A Synopsis

OF

Economic Entomology

By

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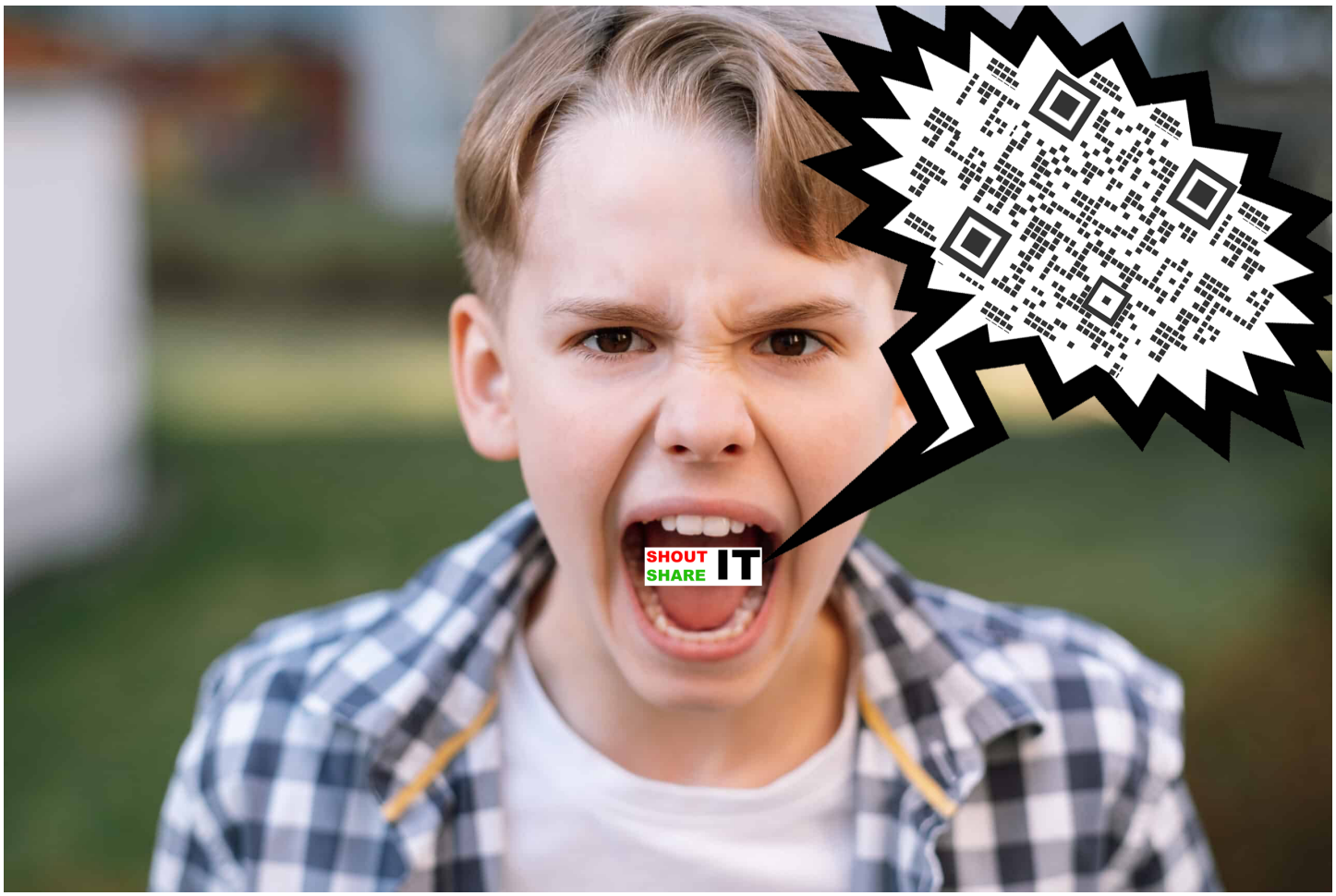
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Economic Entomology

Part I.

A.—THE ARTHROPODA.

In common with the crabs, crayfish and lobsters, the spiders and scorpions, and the centipedes and millepedes, insects have jointed appendages and segmented bodies, distinguishing characteristics of the great branch *Arthropoda*. These near relatives of insects may be grouped into three classes:

(1.) *Crustacea*—Aquatic, gill-breathing Arthropoda with two pairs of antennæ and at least five pairs of legs. Examples, crabs, crayfish, lobsters, shrimps, etc.

(2) *Arachnida*—Air-breathing Arthropoda without antennæ, and with four pairs of legs. Examples, spiders, mites, and scorpions.

(3) *Myriapoda*—Air-breathing Arthropoda with one pair of antennæ, with more than three pairs of legs, and without wings. Examples, centipedes and millipedes.

B.—INSECTS.

The *Hexapoda* or *Insecta* are air-breathing Arthropoda, with one pair of antennæ, with only three pair of legs, and usually with wings in the adult state.

It will be observed that the insects form a very definite class of animals, remarkable for the large number of species. The abundance of some species is so great that frequently they constitute a menace to the life of plants upon which they feed. The economic importance of insects is being rapidly realized by the public in recent years on account of the prominence given to the part taken by the Common House-Fly in the spread of typhoid fever and other diseases, the mosquitoes in malaria and yellow fever, the San Jose Scale and Codling Worm in orchards, the Bollweevil in cotton fields, the Army-Worm and Hessian-Fly in grain fields, the Tent-Caterpillar and Bark-Beetles in orchards and forests, and many other pests that are causing much annoyance, danger and loss.

C.—STRUCTURE OF INSECTS.

(1) External Anatomy.

The body of an insect is divided into three distinct parts—the *head*, the *thorax*, and the *abdomen*, each composed of a number of segments. Each segment again is made up of a number of Sclerites separated by membranous portions. The skeleton is external, and is in form a hollow cylinder with the muscles and nerves within. The skin layer is laminated and hardened by *chitin*, and consists of two layers secreted by the underlying hypodermal cells.

(*a*) *Head.*—The head is composed of six or seven closely united segments, and carries the *eyes* and *antennae*. The mouth is situated on the front ventral surface. The following divisions can be readily recognised:

a. Vertex or crown,

b. Front or face,

c. Genæ or cheeks,

d. Occiput,

e. Clypeus, to which the labrum or upper lip is attached,

f. Gula, to which the labium or lower lip is attached.

The mouth parts consist typically of *labrum*, *mandibles*, *maxillae*, *labium*, and *hypopharynx*, but these parts differ greatly in the different orders. In general there are two types of mouth parts —*Manaibulate*, present in the generalized orders, and in the Orthoptera, Ephemerida, and Coleotera; and the *Suctorial*, present in the Hemiptera, Lepidoptera, Diptera, and Hymenoptera.

(*b*) *Thorax*—The Thorax is composed of three segments—the *pro*, *meso*, and *metathorax*, each having a pair of legs. The meso and metathorax bear wings. Each segment is divided into a dorsal *notum*, a ventral *tergum*, and two laterals, the *pleura*. Each part is again divided by sutures into *Sclerites*—the notum into *praescutum*, *scutum*, *scutellum* and *postscutellum;* the pleuron into *episternum* and *epimeron*.

Abdomen—The abdomen consists typically of ten segments, although eleven or twelve occur in some forms. Each segment has a dorsal plate, the *tergum*, and a ventral plate, the *sternum*, connected by pleural membranes. The terminal portion of the abdomen is modified to form the sexual appendages, or *genitalia*, which assume a great variety of forms.

(*c*) *Antennae*—The antennæ or feelers are sensory organs, and are very variable in structure. They carry the organs of *touch*, and

probably those of *smell* and *hearing* in some cases. On the surface of some of the segments are fine hairs, connected below with nucleated nerve cells which are believed to be *touch* hairs. There are, moreover, pits or oval depressions also connected with a nerve cell, which are thought to be *smell* organs. Other pits situated in patches at the lower end of the segments are believed to be *auditory* organs.

(*d*) *Eyes*—Many insects have two kinds of eyes—*simple* and *compound*. The simple eyes, ocelli, usually three in number, are located on the vertex or front of the head, often in a triangle. Each consists of a convex lens, a retinal area beneath, and a nerve cord. The compound eyes are two, and are located one on each side of the front of the head. They are large, and externally are composed of many facets. Each facet is hexagonal in outline and serves as a lens. Behind the facet are the cystalline and pigment cones, and deeper still are the retinal elements and the optic nerve cord.

(*e*) *Ears*—There are several kinds, and are variously located. In the locusts they are tympanic membranes, located on the base of the abdomen; in the katydids and crickets on the tibiæ of the fore legs. In the mosquitoes and many other groups certain sensitive hairs on the antennæ serve to take up and transmit sound waves.

(*f*) *Legs*—Each leg is composed of the following parts: *coxa*, *trochanter*, *femur*, *tibia*, and *tarsus*. The trochanter in certain Hymenoptera is made of two segments, while the tarsus in most insects is composed of several segments.

(*g*) *Wing*—The two pairs of wings are attached to the meso and metathorax. They are membranous expansions with thickenings along certain lines called *veins* or nerves. These veins often branch, and the spaces between the veins are called *cells*. Much importance is attached in classification to the wing and its veins on account of the great variation not only in the orders and families but even in the genera of a family.

(2) Internal Anatomy.

The internal anatomy of an insect may be conveniently treated under the following heads.

(*a*) Intestinal of Digestive System,
(*b*) Circulatory System,
(*c*) Respiratory System,
(*d*) Nervous System,
(*e*) Reproductive System, and
(*f*) Muscular System.

(a) *Intestinal or Digestive System.*—This system occupies the central portion of the body, and is divided into distinct portions with special functions. The food passes from the mouth into the *pharynx* where it is subjected to the action of saliva secreted by the salivary glands. Thence it passes through the œsophagus into the crop, a folded and membranous pouch, where the action of the saliva is completed. The partially digested food then passes into the *gizzard* or *proventriculus*, a muscular enlargement armed with teeth for the purpose of straining the contents before entering the true *stomach*. Further digestion occurs here through the action of secretions of the *coecal tubes*, often called the *gastric coeca*, which consist of many glandular pouches emptying into the anterior end of the stomach. Most of the digested food is here absorbed and passes into the circulation. Behind the stomach is the *intestine* which consists of three parts—*ileum*, *colon*, and *rectum*. Into the ileum open the *Malpighian tubes* which are excretory in function, similar to the kidneys of higher animals. The undigested portions of food are expelled through the *cloaca* and *anus*.

Some variations may be noted. The œsophagus is long in those those insects that suck their food, and short in herbivorous forms. In sucking insects the gizzard is absent, and the crop is often a side pocket of the œsophagus.

(b) *Circulatory System.*—While there is a circulation in insects the only blood vessel is a dorsal tube or heart lying just beneath the notum. This dorsal tube or heart contains a number of ventricles or chambers, each with a lateral valve which allows the blood to flow in and not out. There are also valves between the chambers so that when the latter contract the blood is forced forward. The blood on leaving the ventricles passes into the *Aortic* portion of the dorsal tube, toward the head, and thence flows into the body cavity bathing all the organs. The blood is usually colorless and consists of two portions—a watery serum and the white blood corpuscles.

(c) *Respiratory System.*—The exchange of gases in respiration is effected by means of a system of small tubes called *trachea*, which extend inwards from the surface and branch to all parts of the body. The external openings are called *spiracles*, situated on the sides of the thoracic and abdominal segments. From each spiracle a short tube runs inward and connects with the trunk tube running along the side of the body. There are thus two main or trunk tracheal tubes, one on each side of the body. Each gives off three large branches to each segment, the upper, the middle, and the lower. Each of these branches subdivides frequently so that every portion of the segment is entered. Moreover, these fine tubes anastomose to form a delicate network, and allow a continuous circulation of air to take place.

In many insects there are in addition large air sacs which serve as reservoirs.

Trachea have a striated appearance due to the thickening of the chitinous wall into a compact elastic spiral, thus preventing the collapse of the tubes.

Special respiratory devices are seen in aquatic insects in the form of *tracheal gills*, which are leaf-like expansions. Sometimes a tracheal tube projects to the surface of the water.

(*d*) *Nervous System.*—The nervous system of insects consists of a series of ganglia joined by a double nerve-cord lying along the ventral surface of the body. Each segment has a double ganglion, but fusion of ganglia occurs in the head, the thorax, the anterior and the posterior portions of the abdomen. The largest ganglion is in the head, and forms the *brain* or *supra-œsophageal ganglion*, lying above the œsophagus. There is also another large ganglion, the *sub-œsophageal*, lying below the œsophagus, and connected with the brain by a double nerve-cord about the œsophagus, the œsophageal nerve collar.

From the brain nerves are given off to the antennæ, eyes, palpi, etc., of the head. The sub-œsophageal ganglion controls the mouth parts. From the ganglia in the thorax and abdomen nerves supply the various segments and control their movement.

(*e*) *Reproductive System.*—In most species the sexes are distinct. The sexual organs are situated in the abdomen and consist in the female of a pair of *ovaries* and a pair of *oviducts* opening into the *vagina*, and frequently externally by an ovipositor; and in the male of a pair of *testes* and a pair of seminal ducts (vasa deferentia) opening into the *ejaculatory duct* and externally by an intromittent organ. In most insects there is in the female a *seminal receptacle*, a dorsal pouch of the vagina, and in the male a *seminal vesicle*, a dilated portion of the vas deferens. The *ova* are formed in the ovarian tubes in different stages of growth, the largest and oldest being nearest the *oviduct*. The *spermatozoa* arise in the follicles of the testes. There are usually a pair of *accessory glands* which secrete mucus which envelopes the spermatozoa and ova.

(*f*) *Muscular System.*—The muscular system of insects is well developed. The muscles are attached to the inner surfaces of the exoskeleton of the body and limbs. There are two sets of longitudinal muscles—one just below the tergum, called the *longitudinal tergal*, the other just above the sternum, called the *longitudinal sternal*. There are also short *oblique tergal* muscles and *oblique sternal* muscles. The muscles of the thorax are more complicated on account of the presence of legs and wings, which have muscles to move them. In the head there are muscles which move the jaws and antennæ. Mention should be made also of the *alary* muscles

Comparison:
Mouth Parts

that aid in contracting the ventricles of the dorsal vessel of the heart.

D.—MOUTH-PARTS.

From an economic standpoint a closer study of some of the structural features of insects is desirable. Reference has already been made to the two general types of mouth parts—the *mandibulate* and the *suctorial*. The mandibulate type, represented in the Orthoptera, Coleoptera, and Neuroptera, has been described, but on account of the great economic importance of suctorial insects represented by the Hemiptera, Diptera, and Hymenoptera, the suctorial type of mouth parts requires further notice.

If the squash-bug be taken as an example, it will be seen on examination that the mandibles and maxillæ are reduced to needle-like structures lying in the groove of the jointed beak, the modified labium. The insect is enabled to send its beak into the underlying tissues of the leaves and stems of plants, and to suck up the juices through the tube formed by the maxillæ. The labrum closes the base of the tube.

In the moths and butterflies the long sucking tube is composed of the two maxillæ joined together, and with them the other mouth-parts are rudimentary.

In the Diptera two or three suctorial types exist. The mosquito and horse-fly, for example, have the piercing type. As in the case of the squash-bug the beak is the modified labium, but the mandibles, maxillæ, hypopharynx and the epipharynx form six lance-shaped organs. In the house-fly and blow-fly the parts are adapted for rasping and sucking.

In the Hymenoptera, as we have seen, both biting and sucking mouth parts are found. The former type is seen in the saw-flies and ants, and the latter in the wasps and bees. In these the hypopharynx forms are elongated tongue around which the maxillae and the labium form a tube, used for lapping and sucking. The mandibles are utilized for getting pollen and wax.

The caterpillars of all Lepidoptera, and the larvæ of many families of the Diptera and Hymenoptera have biting mouth-parts.

A knowledge of the mouth-parts of economic insects is essential to their effective control, as will be seen in later chapters.

E.—REPRODUCTION.

A knowledge of the Reproductive System, including the genitalia, is of importance by reason of the great fecundity of insects and the method of deposition of eggs, whereby injury is sometimes done to plants. In the Neuroptera, Diptera, Lepidoptera and Coleoptera, "the vagina opens to the exterior or else into a cloaca," but

in the Thysanura, Orthoptera, Odonata, Hemiptera and Hymenoptera there is a true *ovipositor*. This organ "consists essentially of three pairs of valves or *gonapophyses*—a dorsal, a ventral, and an inner pair. The two inner valves form a channel through which the eggs are conveyed." There is, however, great variation in the structure of the ovipositor in different families. In the Hymenoptera, for example, it becomes modified for sawing, boring, or stinging.

Parthenogenesis, or reproduction without fertilization, occurs in many insects, is in aphids, Cynips, Lasius (Ant), and Coccids. Several generations of females only which bring forth living young may occur, but at intervals males appear and fertilized eggs are laid.

In some species of the Cecidomyiidæ the young are produced by larvæ. Such a method is called *paedogenesis*. After several generations, however, the last larvæ pupate and form normal male and female flies.

Another method of a sexual reproduction, called *polyembryony*, occurs in certain parasitic insects (Polygnotus), belonging to the Hymenoptera. Each egg produces many embryos, instead of one, which develop into as many adult insects of the same sex.

F.—THE DEVELOPMENT OF INSECTS.

All insects that reach maturity pass through two distinct stages of development—the embryonic changes within the egg, and the changes after leaving the egg until the adult condition is reached. The growth of the embryo within the egg progresses from the segmentation of the ovum to the formation of the *blastoderm* with its ventral plate and germinal groove, and the gradual growth of the *ectoderm*, *mesoblast* and *hypoblast*, from which layers the various organs of the body arise.

The various changes that occur after the hatching of the egg are comprised under the term *Metamorphosis*.

Larval Stage.—The *Larva* varies considerably in appearance in the different orders. In the Lepidoptera the larva is known as a *caterpillar*, characterized by the possession of three pairs of true legs and usually five pairs of pro-legs on the abdominal segments. In the Diptera and Hymenoptera the larva is a maggot characterized by the absence of legs. In the group of Saw-Flies of the Hymenoptera the larvæ are caterpillar-like, possessing three pairs of true legs and often eight or more pairs of pro-legs.

In the Coleoptera the larva is termed a *grub*, which has usually but three pairs of legs.

In the Hemiptera and Orthoptera the larva is known as a *nymph*, which changes by a succession of moults into the adult insect.

The larval stage is the feeding and growing period of the insect's life. After a series of moults, in which the outer skin is shed, the larva reaches its full size.

Pupal Stage.—After a short period of rest the full-grown larva changes to a *pupa* within a pupal skin. Usually the outer skin is shed, but sometimes, as in the Diptera, the outer skin becomes a *puparium*. During the pupal stage not only are all the external organs of the adult insect formed, but even the internal organs undergo profound changes. By the process of *histolysis* the organs break down and reform, and the structures are adapted to the new creature with its new mode of life.

In most insects the pupa is quiescent but it is quite active in the Culicidæ and other families. There is but little difference, except the presence of rudimentary wings, between the larval and pupal stages of the insects belonging to the Hemiptera and the Orthoptera.

Imago or Adult Stage.—The pupa transforms into the imago or adult insect. On the splitting of the pupal case the full grown perfect insect emerges.

Insects that pass through the three distinct stages of larva, pupa and adult are said to possess "complete metamorphosis" (holometabolic); while insects belonging to the Hemiptera, Orthoptera and some of the Neuroptera, in which there is "incomplete metamorphosis" (heterometabolic), show gradual changes from larva to imago.

6.—LOSSES DUE TO INSECTS.

Estimates of the losses inflicted by insect pests on the farm products of Canada are mainly based on similar estimates for the United States.

At the present time it is difficult to form a reliable estimate of average annual losses due to insects from our own records. In some of the older provinces fairly complete records covering a series of years are available, but in the newer provinces such records are incomplete.

Estimates have been made of the losses from some of the more serious pests that occasionally cause great damage, such as the Hessian Fly and the Pea Weevil. In Ontario the loss from the Hessian Fly in each of the years 1900 and 1901 was about two and one-half million dollars, and from the Pea Weevil in 1902 over two millions.

Every person admits large losses due to such pests as Potato Beetle, Codling Moth, San Jose Scale, Tent-Caterpillar, Cattle Horn-Fly, and Grasshoppers, but later pages will show many other in-

jurious forms that remain practically unobserved by the average person, on account of their small size, or their underground or boring habits. The damage they do is attributed to other causes, and frequently reports are unreliable, unless corroborated by competent observers.

In the United States, however, more reliable data are at hand, and the following statement is based on statistics prepared by experts, and published in the Year Book, U. S. Department of Agriculture. The percentage of loss on farm products, such as cereals, hay and forage, cotton, tobacco, truck crops, sugars, fruits, farm forests, miscellaneous crops and animal products, valued at 8,370 millions of dollars in 1909, is greater than ten, and there is a loss of 972 millions, not including those in connection with natural forests and forest products, and products in storage, which would make a probable total loss of over one billion dollars.

If, therefore, we take the percentage loss in the United States, viz., 10%, as a fair basis for insect loss in Canada it can be readily reckoned that the total loss every year in this country exceeds 50 millions of dollars.

Realizing the great loss that occurs every year the people and the Governments of Canada are giving more attention than formerly to the study of insect pests and methods of control.

H.—BENEFICIAL INSECTS.

While the damage done by insects is enormous it must not be supposed that all insects are injurious. As a matter of fact there are more insects that are either beneficial or non-injurious than there are injurious forms. Man owes much to the beneficial insects for the good work they do in keeping the injurious forms in check.

The fact that most plants with colored flowers are largely dependent upon the visits of insects for their fertilization and the setting of their fruit should make it quite evident to everybody that insects play a most important part in the economy of nature, and are no mean things after all. Let one reflect for a moment on the loss to the world if the blossoms of apple, plum, peach, grape, strawberry, raspberry, among fruits were not fertilized by bees and wasps; if the clovers were not visited by bees, and if the hundreds of the beautiful wild flowers of the fields and meadows were allowed to die without setting seeds.

In addition, one should not forget the part played by scavenger and carrion insects that feed upon dead and decaying organic matter. They help to make our surroundings purer and cleaner. Besides, "insects constitute the most important portion of the food of adult fresh water fishes, furnishing 40 per cent. of their food."

according to Dr. Forbes, of Illinois. They also furnish food for most of our birds, although this food may consist of many noxious forms.

There are also many insects that are decidedly beneficial inasmuch as they prey upon injurious forms, or are parasitic upon them. At the present time a great experiment is being conducted in Massachusetts and elsewhere for the suppression of the Gipsy and Brown-tail moths by the importation of certain parasitic insects from Europe and Japan. From an economic point of view it is important for us to know the beneficial forms so that we may not unwittingly destroy them. Few persons, perhaps, fully recognize the valuable work done by the modest lay-bird beetles in keeping plant-lice within bounds. Without the intervention of the lady-bird beetles it is quite probable that most plants would die from the attacks of the fast reproducing plant-lice. Ground-beetles are also important agents in the destruction of injurious larvæ, and their value can hardly be estimated.

Beneficial insects may, therefore, be classified into:

(*a*) Those that prey, or are parasitic, upon injurious forms, such as lady-bird beetles, ground beetles, parasitic diptera and hymenoptera, etc.

(*b*) Those that pollinate plants, such as bees, wasps, moths, etc.

(*c*) Those that play the part of scavengers, feeding upon dead or decaying organic matter, such as carrion beetles, etc.

(*d*) Those that serve as food for fresh water fishes and birds, etc.

(*a*) This class includes members of the Coleoptera, Hymenoptera, Diptera, Hemiptera and Neuroptera. The Coleopterous members are the Lady-Bird beetles, Murky Ground-beetles, and Tiger-beetles.

The *Lady-birds* are small, convex, nearly hemispherical beetles, generally red or yellow and spotted. Their antennæ or feelers are club-shaped, and their tarsi are apparently 3-jointed. They feed upon small insects and the eggs of larger species, and are specially valuable for keeping plant-lice in check. Among the more common forms are:

The 2-spotted Adalia (Adalia bipunctata) black spots on red wing covers.

The 2-spotted Chilicorus (C. bivulnerus) with orange spots on blue-black wing covers.

The 2-spotted Hyperaspis (H. signata).

The spotted Megilla (M. maculata), black spots on red wing covers.

The 5-spotted Hippodamia (H. 5 signata).

The Convergent Hippodamia (H. convergens).

The 13-spotted Hippodamia (H. 13-punctata).

The 5-marked Coccinella (C. 5-notata).

The 9-marked Coccinella C. 9-notata).

The 15-spotted Anatis (A. 15-punctata).

Pentilia misella (Pitiful Lady-bird), a small black beetle, feeds on the San Jose Scale.

Vedalia cardinalis (Australian Lady-bird) was imported into California from Australia to control the Cottony-Cushion Scale of the orange groves.

Chilocorus similis (Chinese Lady-bird) was imported into the United States from China to control the San Jose Scale, but it has failed to breed to any extent.

The larvæ of Lady-birds are quite active and hunt for their prey. Some bear spines, while others are protected by fine white down.

Ground-Beetles (Carabidæ) are active forms that live on the surface of the ground. They are usually black, but some have bright colors. They hide under stones or boards in the day-time but leave their shelters at night. They destroy large numbers of caterpillars, such as cutworms, canker-worms, tent-caterpillars, and the grubs of curculio. The larvæ feed underground on the larvæ of leaf-feeding insects.

The most common members of this group are:

(*a*) *The Murky Ground Beetles*, species of Harpalus, Pterostichus, Lebia and Galerita.

(*b*) The Metallic Ground-Beetles, Calosoma scrutator with green wing covers, and C. calidum, the "fiery hunter," with rows of gold dots on the black wing covers.

The ground-beetles have thread-like antennæ, and 5-pointed tarsi with legs fitted for running.

The Tiger-Beetles (Cicindelidae) are carnivorous insects, and most active in the day time. Their activity, markings, and stealthy habits have given them their name. In structure they are closely related to the Ground-Beetles. They have thread-like antennæ and 5-jointed tarsi.

The larvæ of these beetles live in holes in the ground and prey upon unwary insects. They have large heads, immense jaws, and long sprawling legs. There are two prominent humps on the back.

The Hymenoptera possess several very important beneficial forms, mostly parasites.

The Ichneumon-Flies (Ichneumonidæ) vary greatly in size, and some of the female possess a protruding ovipositor. A common example is *Thalessa*, a very long tailed Ichneumon, which bores a

hole in wood infested with Pigeon Tremex borers and deposits an egg beside the larval Tremex.

(*a*) *Trogus*, which parasitizes the chrysalids of Papilio.

(*b*) *Ophion*, with a compressed body, living on the Polyphemus moth, and yellow necked caterpillar.

The Braconids (Braconidæ) are smaller and also parasitic. The most common genera are Microgaster, whose cocoons are often found on the backs of sphinx and cabbage butterfly larvæ; and Aphidius that parasitizes plant-lice.

The Chalcids or *Chalcis Flies* (Chalcididæ) are minute metallic insects. One species Pteromalus puparum is a parasite of the chrysalids of the cabbage butterfly. Another (Aphelinus) is parasitic on scale insects.

The Proctotrypids are very minute parasitic hymenoptera preying upon the eggs of other insects.

Besides these parasitic forms there are predaceous Hymenoptera that feed their larvæ on insects. such are the mud-wasps, digger-wasps, wood-wasps, etc. They fill the brood cells with caterpillars or grasshoppers, or plant lice, or grubs of small beetles or flies. Sphecius makes use of cicadas as food for its young.

Among the Diptera two families are directly beneficial in preying upon injurious insects:

The Tachinids or Tachina Flies (Tachinidæ) are bristly parasites and are closely related to the ordinary house-flies. These parasitize many kinds of caterpillars and sawfly larvæ, either by inserting eggs within the bodies of their victims or by allowing the victims to swallow the eggs that are deposited on leaves.

The Syrphids or Flower Flies (Syrphidæ) lay their eggs in colonies of plant-lice which are devoured by the larvæ. They are large, often bee-like in form.

The Hemiptera include a few beneficial forms, mostly belonging to the Assassin-bug Family (Reduviidæ). They are predaceous, sucking the blood of other insects. Sometimes higher animals, including man, are attacked. The following forms are here noted:

Melanolestes picipes, a large black form.

Opsicœtus personatus, or Masked Bed-bug Hunter, also one of the Kissing Bugs, is black and over ½ inch long.

The Stink-bug Family (Pentatomnidæ) also furnishes a few beneficial species, although a very large percentage of the species is injurious to plant life:

Podisus spinosus (Spined Tree-Bug) destroys potato beetles and currant worms.

Perillus bioculatus has appeared in large numbers in potato fields in Ontario, where it is destroying potato beetles.

Among the Neuroptera are some important beneficial forms, known as Aphis-lions and Ant-lions.

The adults of *Aphis-lions*, also called Lace-winged Flies, are readily recognised by their delicate veined green wings. Their larvæ are predaceous and destroy large numbers of plant-lice. Their mandibles are very long. The genus Chrysopa is the main one in the Family Chrysopidæ.

Ant-lions (Myrmeleonidae) as adults have "long narrow delicate wings and a slender body." The larvæ are very predaceous and possess enormous mandibles. They capture their prey by using pit-falls.

Part II.

KEY TO INSECTS INJURIOUS TO FARM, GARDEN AND ORCHARD CROPS.

I.—Insects Injurious to Wheat, Rye, Barley and Oats.

The Roots.

1.—Plants are stunted, turn yellow, and wither or die; roots eaten.

(*a*) Smooth, slender wire-like, 6-legged worms are present in the soil.—*Wireworms.*

(*b*) There are present in the soil large soft-bodied whitish grubs, with brown heads and hinder portion of body thicker than fore end. When disturbed grubs curl up.—*White grubs.*

(*c*) Large dirty brown maggots, ½—1 inch long.—*Meadow Maggots.*

The Stems and Leaves:

1. Young plants dwarfed, and color changed to yellow or brown; stems shrivelled at the base, often bent or broken off; "Flax-seed objects found embedded at or near the base.—*Hessian Fly* (Cecidomyia destructor..

2. Stems above last joint dead, and the heads white—"Silver-top" or "whitehead" disease. Greenish maggot in stem above last joint. —*Wheat Stem Maggot* (Meromyza Americana) and American Frit-Fly (Oscinis carbonaria).

3. Swellings or galls on the joints, and the stems bent or broken before harvest.—Joint Worm (Isosoma tritici).

4. Leaves sickly and whitish; the presence of small red and larger black and white bugs.—*Chinch Bug* (Blissus leucopterus).

5. Stems and leaves sickly; the presence of many green plant lice.—*Wheat Plant Louse* (Nectarophora avenae).

6. Stems and leaves eaten by large dingy caterpillars.—*Army-worm* (Leucania unipuncta).

7. Leaves eaten by grasshoppers.—*Red-legged grasshoppers* (Melanoplus femur-rubrum).

The Heads:

1. Heads turn white and grains are shrivelled or imperfectly filled.—*Wheat Stem Maggot* (Meromyza Americana) and *American Frit-Fly* (Oscinis carbonaria).

2. Heads shrivelled and blighted, and imperfectly filled, with the presence of orange-colored maggots.—*Wheat Midge* (Diplosis tritici).

3. Heads covered with green plant lice.—*Grain Louse* (Nectarophora avenæ).

II.—Insects Injuring Clover and Alfalfa.

(Consult Bul. 134 Illinois Agric. Exper. Station, 1909.)

The Roots:

(*a*) Second year plants wilt and die, and break off easily at the crown. Main root tunnelled and occupied by white footless or little dark brown cylindrical beetles.—*Clover Root Borer* (Hylastinus obscurus).

(*b*) Plants wilted and leaves die, mealy bugs near crown of root.—*Clover Root Mealy Bugs* (Pseudococcus trifolii).

The Stems:

(*a*) A long burrow with brown discolored walls in the pith of the stem which falls to the ground prematurely.—*Clover-Stem Borer* (Languria mozardi).

(*b*) Stems cut off or eaten.—*Cutworms* and *Army Worms* (Leucania unipuncta) or *Grasshoppers.*

(*c*) Stems and leaves wither and die; plants covered with big green long legged plant lice.—*Pea* or *Clover Plant-Louse* (Macrosiphum pisi).

The Leaves:

(*a*) Leaves full of round holes, and edges gnawed.—*Clover-Leaf Weevil* (Phytonomus punctatus).

(*b*) Leaves eaten and with a ragged appearance.—*Grasshoppers.*

(*c*) Leaves folded along midrib, yellowish or brownish, with white or orange maggots or silken cocoons within the folds.—*Clover Leaf Midge* (Cecidomyia trifolii).

The Heads and Seed:

(*a*) Florets at blossoming time green and undeveloped; the ovaries empty or with an orange pink or whitish maggot.—*Clover-Seed Midge* (Cecidomyia leguminicola).

(*b*) Seeds eaten, and become brown, brittle, and hollow; affected seeds are dull brown and often misshapen and of small size; maggot minute, white and footless.—*Clover-Seed Chalcid* (Bruchophagus funebris).

(*c*) Unopened blossoms destroyed, a cavity eaten in the head.—*Clover-Seed Caterpillar* (Enarmonia interstinctana).

Stacked or Stored Clover Hay:

(*a*) Hay containing white silky webs and particles of excrement.—*Clover Hay-Worm* (Hypsopygia costalis).

III.—Insects Injuring Indian Corn.

Planted Seed:

(*a*) The plant fails to come up after planting; grain destroyed by a footless maggot which eats out the interior.—*Seed-Corn Maggot* (Phorbia fusciceps).

(*b*) The plant fails to come up, or the young plant suddenly wilts after it is above ground; the presence of hard smooth yellowish wire-like worms.—*Wireworms* (several species).

The Roots:

(*a*) Young plants are killed or withered; roots eaten.—*White Grubs* or *Wireworms*.

(*b*) Young plants unequal in growth; roots dwarfed without external injury; presence of ants.—*Corn-Root Louse* (Aphis maidiradicis).

The Stalk:

(*a*) Plants are cut off near surface of ground.—*Cutworms*.

(*b*) Plant unthrifty and covered with greenish plant lice.—*Corn-Plant Louse* (Aphis maidis).

The Leaves:

(*a*) Leaves thickly covered with green plant lice.—*Corn-Plant Louse* (Aphis maidis).

(*b*) Leaves eaten.—*Army Worm* (Leucania unipuncta) or *Grasshopper*.

The Ear:

(*a*) Developing kernels eaten, with much excrement.—*Corn-Ear Worm* (Heliothis armiger).

(*b*) Stalks of ears covered with plant lice.—*Corn Plant Louse* (Aphis maidis).

IV.—Insects Injuring Peas and Beans.

The Planted Seeds:

(a) Plant fails to come up, may be caused by *White Grubs* or *Wireworms*, or *Bean* or *Seed Corn Maggot*.

The Stalks and Leaves:

(a) Plants cut off at night.—*Cutworms*.

(b) Plants unhealthy, often killed due to sucking lice.—*Pea Louse* (Macrosiphum pisi).

The Pods:

(a) Seeds (peas) within the pod partly eaten and web-covered; pellets of excrement about injured seed.—*Pea Moth* (Semasia nigricana).

(b) Seeds within the pod (peas) perforated with holes; footless grubs within.—*Pea Weevil* (Bruchus pisorum).

(c) Seeds (Beans) perforated with (sometimes many) holes; footless grubs within.—*Bean Weevil* (Bruchus obtectus).

V.—Insects Injurious to Root Crops.

Turnips, rape, mangels, and carrots.

(Consult Bul. 52 C. E. Farm, Ottawa, and Bul. 60, Ill, Exp. Sta.)

The Roots:

(a) Tips of roots of young carrots with rusty patches on surface, or rust colored tunnels in the pulp, due to slender yellowish white maggots.—*Carrot Rust Fly* (Psila rosæ).

(b) Roots of turnips bored or tunnelled by minute grubs.—*Turnip Flea Beetle* (Phyllotreta vittata); *Cabbage Root Maggot* (Phorbia brassicae).

(c) Roots cut off.—*Wireworms, white Grubs, Cutworms.*

The Stem and Leaves:

(a) Young plants cut off at the ground.—*Cutworms.*

(b) Surface of first leaves of turnip and rape eaten into small holes by small black, striped beetles.—*Turnip Flea Beetle* (Phyllotreta vittata).

(c) Leaves partly consumed by [illegible] caterpillars.—*Cabbage Worm* (Pontia rapæ).

(*d*) Leaves eaten by caterpillars with black and yellow stripes.—*Zebra Caterpillar* (Mamestra picta).

(*e*) Leaves wilt and turn yellow, and presence of greenish lice.—*Turnip Plant Louse*.

(*f*) Young leaves eaten into holes and irregular blotches by small active green caterpillars.—*Diamond Back Moth* (Plutella cruciferarum).

(*g*) Under-surface of leaves covered with a very fine loose web; leaves yellowish in patches, and minute red objects present.—*Red Spiders*.

VI.—Insects Injurious to the Potato Crop.

The Tubers:

(*a*) Surface of tuber eaten and eyes sometimes destroyed so that growth does not take place: or holes bored in the tuber.—*White Grubs, Wireworms, Millipedes*.

The Stalks and Leaves:

(*a*) Stalks cut off at the ground.—*Cutworms*.

(*b*) Leaves eaten and infested with reddish soft grubs and striped beetles.—*Colorado Potato Beetle* (Leptinotarsa decemlineata).

(*c*) Leaves riddled with small holes or surface eaten in spots.—*Potato Flea Beetle* (Epitrix cucumeris).

(*d*) Leaves eaten and with a ragged appearance; presence of long black or striped beetles.—*Blister Beetles* (Epicauta spp.).

(*e*) Stalks wilt and die, tunnel in stalk near the ground, and presence of a white footless grub.—*Potato Stalk Borer* (Trichobaris trinotata).

VII.—Insects Injurious to Garden Vegetables.

Under the term "Garden Vegetables" may be included Asparagus, Beets, Cabbage, Cauliflower, Celery, Cucumber, Onion, Parsnip. (Carrots, beans peas and potatoes have already been considered.)

The Roots:

(*a*) Roots of cabbage and cauliflower and bulb or base of onion mined by white maggots.—*Root Maggots* (Phorbia brassicæ and Phorbia ceparum).

(*b*) Roots of cucumber, squash, melon and pumpkin eaten, and plants fail to come up.—*White Grubs, Wireworms*.

(c) Roots of cucumber, etc., gnawed and mined, plants wilt and die.—*Striped Cucumber Beetle* (Diabrotica vittata).

The Stems and Leaves:

(a) Young plants cut off near surface of ground.—*Cutworms.*

(b) Stalks and vines and leaves of cucumbers, etc., eaten, and base mined by small white grubs.—*Cucumber Beetles* (Diabrotica spp.).

(c) Leaves of cabbage, etc., ragged, eaten by pale green caterpillar.—*Cabbage Worm* (Pontia rapæ).

(d) Vines of cucumber, etc., wilted and presence of large dark stink-bugs on leaves.—*Squash Bug* (Anasa tristis).

(e) Leaves and vines of cucumber, etc., sickly and dirty, undersurfaces infested with greenish black lice.—*Melon Plant Louse* (Aphis cucumeris).

(f) Surface of leaves of cucumber, etc., eaten by small black beetles—*Cucumber Flea Beetle* (Epitrix cucumeris).

(g) Leaves of cabbage, etc., wilted down, and under surface covered with greenish plant lice.—*Cabbage Plant Louse* (Aphis brassicæ).

VIII.—Insects Injurious to Apples.

The Roots:

1. Causing knots or swellings on the smaller roots, bluish-white mouldy lice.—*Woolly Aphis* (Schizoneura lanigera).

The Trunk, Branches and Twigs:

(a) Producing longitudinal slits in the bark; eggs under the edges of the slits.—*Buffalo Tree-Hopper* (Ceresa bubalus).

b. Fixed to Bark:

1. Producing an ashy gray incrustation on the bark; scales round and gray and black.—*San Jose Scale* (Aspidiotus perniciosus).

2. Bark rough with mussel-shaped scales.—*Oyster-Shell Scale* (Lepidosaphes ulmi).

3. Bark scurfy with white scales.—*Scurfy Scale* (Chionaspis furfurus).

c. Making Tunnels in the Wood:

1. Large square-headed legless borer at or near the ground in

tunnels, with sawdust-like excrement.—*Round-Headed Borer* (Saperda candida).

2. Large flat-headed legless borer in upper trunk in tunnels with sawdust-like excrement.—*Flat-Headed Borer* (Chrysobothris femorata).

3. Large larva in decaying wood.—*Eyed Elater* (Alaus oculatus) and *Rough Osmoderma* (Osmoderma scabra).

d. Making tunnels between the bark and wood:

1. *Fruit Bark Beetle* (Scolytus rugulosus).

(*e*) White woolly patches on the twigs which are usually scarred.—*Woolly Aphis* (Schizoneura langera).

(*f*) Green soft-bodied insects in clusters on young growths, and particularly at ends of twigs, producing distortions.—*Apple Aphis* (Aphis mali).

(*g*) Snout Beetles gnawing off the bark in patches.—*Imbricated Snout-Beetle* (Epicaerus imbricatus).

The Buds:

(*a*) Folding together the opening leaves and feeding within.—*Oblique Banded Leaf-Roller* (Cacoecia rosaceana), and *Leaf Crumpler* (Phycis indiginella).

(*b*) Eating the centre of the bud, or tunnelling it.—*Eye-Spotted Bud Moth* (Tmetocera ocellana).

(*c*) Measuring Worms, eating leaves of buds.—*Canker Worms* (Alsophila pometaria).

(*d*) Caterpillars feeding with pistol-shaped cases and eating irregular holes in the bud leaves.—*Pistol Case-Bearer* (Coleophora malivorella).

(*e*) Caterpillars feeding within cigar-shaped cases and eating small round holes in the bud leaves.—*Cigar Case-Bearer* (Coleophora fletcherella).

The Leaves:

(*a*) Gregarious caterpillars.

1. *Caterpillars protected by webs:*

(*a*) Webs in forks of branches in spring.—*Tent Caterpillar* (Clisiocampa Americana).

(*b*) Webs covering the leaves in summer and early autumn.—*Fall Web-Worm* (Hyphantria cunea).

(*c*) Leaves partly eaten and drawn together by a web.—*Palmer Worm* (Ypsolophus pometellus).

2. *Caterpillars not protected by a web:*

(*a*) Clustered on limbs.—*Yellow-necked Caterpillar* (Datana ministra).

(*b*) *Red-Humped Apple-Tree Caterpillar* (Oedemasia concinna)

3. *Green soft-bodied insects with sucking mouths.—Plant Lice.*

(*b*) Solitary Caterpillars.

1. *Protected Caterpillars:*

(*a*) Mining within the leaf, pupa inside of folded leaf.—*Apple-Leaf Miner* (Tischeria malifoliella).

(*b*) Mining within the leaf, mature larva and pupa within small oval seed-like bodies.—*Resplendent Shield-Bearer* (Aspidisca splendoriferella).

(*c*) Feeding within pistol-shaped cases, which stand out from the leaf.—*Pistol Case-Bearer* (Coleophora malivorella).

(*d*) Feeding within cigar-shaped cases, which stand out from the leaf.—*Cigar Case-Bearer* (Coleophora fletcherella).

(*e*) Feeding within folded leaves.—*Leaf Roller* (Teras malivorana and Cacoecia rosaceana).

(*f*) Feeding within tubes of silk, open at both ends, on epidermis and inner tissues leaving the veinlets.—*Bud Moth* (Tmetocera ocellana).

(*g*) Feeding on tissues of leaves beneath a silk web.—*Apple-Leaf Skeletonizer* (Pempelia Hammondi).

2. *Unprotected Caterpillars:*

(*a*) Measuring worms in spring, feeling in the day-time.—*Canker Worms* (A. pometaria and P. vernata).

(*b*) Sleek 16-legged caterpillars, feeding at night.—*Cutworms.*

(*c*) Large green caterpillar, covered with spiny tubercles.—*Cecropia Moth.*

(*d*) Large apple-green caterpillar with white oblique stripes on sides.—*Polyphemus Moth* (Telea polyphemus).

(*e*) Hairy caterpillar with long black tufts over head and tail.—*Tussock Moth* (Hemerocampa leucostigma).

(*f*) Large green caterpillar with a reddish brown horn at tail, and seven olique stripes on each side.—*Apple Sphinx* (Sphinx gordius).

(*g*) Small caterpillar with brown head and yellowish-green body, feeding on leaves.—*Apple-Tree Bucculatrix* (Bucculatrix pomifoliella).

3. *Beetles:*

(*a*) Large brown beetle feeding at night on leaves. *May Beetle* (Lachnosterna fusca).

(*b*) Small brown beetles, feeding at night. *Leaf Beetles.*

The Fruit:

(*a*) Boring tunnels through the fruit:

1. Tunnels mostly about the core—brown excrement often visible at opening at blossom end of apple.—*Codling Moth* (Carpocapsa pomonella).

2. Tunnels irregular and numerous.—*Apple Maggot* (Trypeta pomonella).

(*b*) *Puncturing the fruit:*

1. Puncturing the fruit and distorting it, a 4-humped beetle.—*Apple Curculio* (Anthonomus quadrigibbus), *Plum* Curculio (Conotrachelus nenuphar).

2. Purplish spots about the circular scales.—*San Jose Scale* (Aspidiotus perniciosus).

(*c*) *Eating holes in the fruit:*

1. Large light yellow or apple green caterpillars with a narrow cream-colored stripe along middle of the back.—*Green Fruit Worms* (Xylina sp.).

2. Beetle, yellowish, hairy, one-half inch long.—*Bumble Flower-Beetle* (Euphoria inda).

IX.—Insects Injurious to the Plum.

The Roots:

(*a*) Burrowing about the crown of the roots, occasionally in young trees.—*Peach-Tree Borer* (Sannina exitiosa).

The Trunk, Branches and Twigs:

(*a*) Making tunnels in the wood, sawdust-like excrement at the mouth of tunnels.—*Flat-Headed Borer* (Chrysobothris femorata).

(*b*) Making tunnels in the bark.—*Fruit Bark-Beetle* (Scolytus rugulosus).

(c) Bases of buds perforated, the bark becomes discolored, and the leaves and fruit wither.—*Pear-Blight Beetle* (Xyleborus pyri).

(d) Fixed to bark:

(1) Flat or saddle-shaped, or hemispherical dark brown scales. Wintering forms are small and flattish. Large scales after midsummer are brittle and contain only a whitish dust or empty eggshells.—*Plum Lecanium* (Lecanium cerasifex).

(2) Ashy gray appearance of bark of badly infested trees; small gray or black circular scales.—*San Jose Scale* (Aspidiotus perniciosus).

(3) Mussel-shaped scales, with whitish eggs underneath in winter.—*Oyster-Shell Scale* (Lepidosaphes ulmi).

(4) Bark scurfy with scales, purplish eggs underneath in winter.—*Scurfy Scale* (Chionaspis furfurus).

(e) Producing longitudinal slits and eventually oval-shaped scars.—*Buffalo Tree-Hopper* (Ceresa bubalus).

The Leaves:

(a) Feeding in Colonies.

(1) Protected by webs in the forks of branches.—*American Tent-Caterpillar* (Clisiocampa Americana).

(2) Protected by webs covering the leaves.—*Fall Web-Worm* (Hyphantria textor).

(3) Not protected by webs, greenish lice with suckling mouths.—*Plum-Leaf Aphis* (Aphis prunifolii).

(b) Solitary.

(1) Measuring worms, feeding in the day time and in spring.—*Canker Worms* (Alsophila pometaria).

(2) Fat, greasy caterpillars, feeding at night in spring.—*Cutworms.*

(3) Hairy caterpillars with long black plumes over head and tail.—*Tussock Moth* (Hemerocampa leucostigma).

(4) Large buzzing beetle.—*June Bug* (Lachnosterna fusca).

(5) Large apple-green caterpillar, with a tail horn, and with seven broad oblique white stripes along each side.—*Plum-Tree Sphinx* (Sphinx drupiferarum).

Other larvæ are occasionally found feeding on the leaves of plum—*The Viceroy* (Limenitis disippus), *Polyphemus* and *Cecropia.*

The Fruit:

(*a*) Puncturing and making a crescent-shaped slit in the skin of the young fruit, which soon drops.—*Plum Curculio* (Conotrachelus nenuphar).

(*b*) Making a round hole in the young fruit.—*Plum Gouger* (Coccotorus scutellaris).

(*c*) Eating holes in the ripe fruit.—*Bumble Flower-Beetle* (Euphoria inda).

(*d*) Eating holes in the half-ripe fruit.—*Rose Chafer* (Macrodactylus subspinosus).

X.—Insects Injurious to the Cherry.

The Root:

(*a*) Thick whitish grub, with brown head and legs, feeding in decaying roots. Beetles large with powerful mandibles.—*Stag Beetle* (Lucanus dama).

(*b*) Large white fleshy grub, with reddish head, feeding in old roots.—*Rough Osmoderma* (Osmoderma scabra).

The Trunk, Branches and Twigs:

(*a*) A snout beetle gnawing the twigs and fruit.—*Imbricated Snout Beetle* (Epicaerus imbricatus).

(*b*) A small beetle boring in the branches just above a bud, and burrowing downwards.—*Apple Twig Borer* (Amphicerus bicaudatus).

(*c*) A flattened grub tunneling in the bark and sap-wood; beetle bronzy metallic.—*Divaricated Buprestis* (Dicerca divaricata).

(*d*) Large sucking insect with transparent wings inflicting wounds on the smaller limbs, and depositing eggs therein in August and September.—*Dog-Day Cicada* (Cicada tibicen).

(*e*) Small circular scales, black in winter, with a circular depression about a central nipple.—*San Jose Scale* (Aspidiotus perniciosus).

The Leaves:

(*a*) A small beetle feeding on the leaves of red cherry.—*Cherry-Leaf Beetle* (Galerucella clavicollis).

(*b*) A slug, shiny, dark green, one-half inch long, feeding on soft tissues, leaving the veins.—*Pear or Cherry Slug* (Eriocampa cerasi).

(*c*) Shining black plant lice infesting the terminal twigs chiefly, which become distorted and discolored.—*Cherry Aphis* (Myzus cerasi).

(*d*) Large, bluish green caterpillar, two inches long with blue warts on each segment, and coral red ones on the third and fourth segments.—*Promethea Moth* (Callosamia promethea).

(*e*) Large pale green spiny caterpillar, striped on each side with white and lilac.—*Io Moth* (Hyperchiria Io).

(*f*) Caterpillars in colonies protected by webs in forks of branches in spring.—*American Tent Caterpillar* (Malacosoma Americana) and *Forest Tent Caterpillar* (M. disstria) not in webs.

(*g*) Caterpillars in colonies protected by webs covering the leaves in summer and early autumn.—*Fall Web Worm* (Hyphantria cunea), and other insects, most of which also attack the leaves of apple.

The Fruit:

(*a*) Making a crescent cut on the cherry; grub, white and footless, with a brownish horny head, feeding within.—*Plum Curculio* (Contrachelus nenuphar).

(*b*) Yellowish white maggots feeding on the pulpy juices near the pit, inducing a rotting.—*Cherry Frit Fly* (Rhagoletis cingulata).

XI.—Insects Injurious to the Peach.

Attacking the Root and Lower Trunk:

(*a*) Tunneling in the bark and sapwood of the root, causing an exudation of gum, which is seen at base of tree mingled with the castings.—*Peach Tree Borer* (Sannina exitiosa).

Attacking the Trunk and Branches:

(*a*) In early spring a minute caterpillar bores into the shoots of new leaves, killing the growing terminals.—*Peach Twig Borer* (Anarsia lineatella).

(*b*) Black hemispherical scales attached to the bark.—*Peach Leaf Lecanium* (Lecanium nigrofasciatum).

(*c*) A beetle eating the buds and gnawing into the base of the twigs, causing them to break and fall.—*New York Weevil* (Ithycerus noveboracensis).

(*d*) Round scales, gray or black, twigs presenting a scurfy appearance.—*San Jose Scale* (Aspidiotus perniciosus).

(*e*) Oval scars and longitudinal slits on back.—*Buffalo Tree-Hopper* (Ceresa bubalus).

Attacking the Leaves:

(*a*) Plant lice, living in colonies under the leaves, causing them to thicken and curl.—*Peach Tree Aphis* (Myzus persicae).

(*b*) Minute round sca , usually along the veins.—***San Jose Scale*** **(Aspidiotus perniciosus).**

(*c*) Caterpillars protected:

(1) In a tortuous tube.—***Leaf Crumpler*** **(Mineola indiginella).**

(2) In folded leaves.—***Oblique Banded Leaf Roller*** **(Cacoecia rosaceana).**

Attacking the Fruit:

(*a*) Long legged, yellowish beetles eating holes in half-grown peaches.—***Rose Chafer*** **(Macrodactylus subspinosus).**

(*b*) Large yellow, hairy beetles, eating holes in ripe peaches.—***Bumble Flower-Beetle*** **(Euphoria inda).**

(*c*) Small snout beetles making a puncture and crescent in the young fruit.—***Plum Curculio*** **(Conotrachelus nenuphar).**

XII.—Insects Injurious to the Raspberry and Blackberry, Etc.

The Roots and Base of Canes:

(*a*) Large grub over two inches long, boring large tunnels in the woody portion of main root. The canes suddenly die—***Giant Root-Borer*** **(Prionus laticollis).**

(*b*) Canes at base of main root girdled by a yellowish white caterpillar in late summer and autumn.—***Bramble Crown Borer*** **(Bembecia marginata).**

The Canes:

(*a*) Longitudinal row of punctures on canes.—***Snowy Tree-Cricket*** **(Œcanthus niveus).**

(*b*) Tips of raspberry canes wilting in early summer, due to a girdling of the canes inside the bark.—***Raspberry Cane Maggot*** **(Phorbia rubivora).**

(*c*) Tips of shoots of raspberry wilting, two rows of punctures one inch apart at base of wilted portion, with a small hole between. Canes are burrowed to the base before autumn.—***Raspberry Cane Borer*** **(Oberea bimaculata).**

(*d*) Swellings on canes of raspberry and blackberry.—***Red-Necked Cane-Borer*** **(Agrilus ruficollis).**

The Buds:

(*a*) A small snout beetle, puncturing the flower stem close to the buds, and also the buds.—***Strawberry Weevil*** **(Anthonomus signatus).**

(*b*) A small yellowish beetle eating the flower buds, which fail to open or wither.—*Pale Brown Byturus* (Byturus unicolor).

(*c*) A small brownish caterpillar eating the opening buds.—*Bud Moth* (Tmetocera ocellana).

The Leaves:

(*a*) Insects sucking the sap of young growing p..ts, and arresting their development.—*Tarnished Plant Bug* (Lygus pratensis).

(*b*) Suckers and leaves curl up with enclosed lice.—*Bramble Flea-Louse* (Trioza tripunctata).

(*c*) Small larva eating the leaves in spring.—*Raspberry Saw-Fly* (Monophadnus rubi).

The Fruit:

(*a*) A looper feeding on fruit of raspberry and blackberry.—*Raspberry Geometer* (Synchlora glaucoria).

XIII.—Insects Injurious to the Gooseberry and Currant.

The Canes:

(*a*) Tips of canes girdled and wilted; pith tunneled.—*Currant Stem Girdler* (Janus integer).

(*b*) Center of cane tunneled by a white caterpillar.—*Imported Currant Borer* (Sesia tipuliformis), and *Snowy Tree-Cricket* (Œcanthus niveus).

(*c*) Small flat circular scales, black or gray, with a depressed ring about a central nipple in black forms.—*San Jose Scale* (Aspidiotus perniciosus).

(*d*) Oval, hemispherical scales.—*Currant Lecanium* (Lecanium ribis).

(*a*) Larvæ, 20-legged, dull white when young, then greenish with black spots, finally greenish yellow, eating holes in the leaves in early spring.—*Imported Currant Worm* (Nematus ribesii).

(*b*) Leaves curled, blistered, and with a reddish appearance on upper surface, caused by yellowish plant lice.—*Currant Plant Louse* (Myzus ribis).

(*c*) Leaves turning brown and dying.—*Four-Lined Leaf-Bug* (Poecilocapsus lineatus).

(*d*) Measuring worm feeding on leaves of gooseberry and black currant.—*Currant Span-Worm* (Diastictis ribearia).

(*e*) White spots on leaves, produced by a pale green sucking

insect occurring on the under surface.—*Currant Leaf Hopper* (Empoa albopicta).

The Fruit:

(*a*) Greyish caterpillar boring into young fruit and eating out its contents.—*Gooseberry Fruit Worm* (Zophodia grossulariæ).

(*b*) Purplish spots surrounding small circular scales.—*San Jose Scale* (Aspidiotus perniciosus).

(*c*) Yellow oval maggots eating the gooseberry.—*Gooseberry Midge* (Cecidomyia grossulariæ).

(*d*) Small white grub eating the currant and gooseberry, causing the fruit to turn red and fall.—*Currant Fly* (Epochra Canadensis).

XIV.—Insects Injurious to the Grape.

(Consult Bul. 331, N.Y. Aq. Exp. St. and Farmers' Bul. 70, U.S. Dep. Ag.)

The Roots:

(*a*) Producing little irregular spherical galls on rootlets and larger roots, causing death.—*Grape Vine Phylloxera* (Phylloxera vastatrix).

(*b*) Large borer, cutting a tube through the root near the surface.—*Broad-Necked Prionus* (Prionus laticollis).

(*c*) Grub eating the bark of both the large and small roots.—*Grape Vine Fidia* (Fidia viticida).

The Branches:

(*a*) Young shoots suddenly break off or droop in spring; a small hole just above the base of the shoot leads into a burrow.—*Apple Twig Borer* (Amphicerus bicaudatus).

(*b*) Canes show roughened, longitudinal rows of perforations in the bark.—*Snowy Tree Cricket* (Œcanthus niveus).

(*c*) Canes exhibiting white cottony masses attached to a reddish-brown scale.—*Cottony Scale* (Pulvinaria innumerabilis).

(*d*) Canes exhibiting white frothy masses which resemble spittle.—*Spittle Insect* (Aphrophora, sp.).

The Leaves:

(*a*) Leaves riddled with irregular holes about mid-summer by a little beetle.—*Grape Vine Fidia* (Fidia viticida).

(*b*) Boring into buds in spring, also eating small holes in expanding leaves; small, shining, blue beetle.—*Grape Vine Flea Beetle* (Haltica chalybea).

(c) Long-legged, brownish beetles eating the blossom, leaves and fruit.—*Rose Chafer* (Macrodactylus subspinosus).

(d) Greenish caterpillar, feeding within a folded leaf and skeletonising it, about mid-summer.—*Grape Leaf Folder* (Desmia maculatus).

(e) Leaves blotched and scorched, finally curling up and falling, by little jumping insects.—*Grape Thrips or Leaf Hopper* (Typhlocyba comis).

(f) Large greenish caterpillar, with a pale yellow stripe down each side, and a horn near tail.—*Grape Vine Sphinx* (Darapsa myron).

(g) Several other sphingid larvæ feed on the leaves of the [illegible]

(h) Black beetle eating the tissues on the upper surface of the leaves, and discoloring them.—*Red Headed Systena* (Systena frontalis).

(i) Producing reddish, elongated, conical galls on the leaves.—*Trumpet Grape Gall* (Vitis viticola).

(j) Large reddish yellow beetle with six black spots on wing cover eating holes in leaves.—*Spotted Pelidnota* (Pelidnota punctata).

The Fruit:

(a) Ripening fruit discolored and burrowed by a whitish caterpillar.—*Grape Berry Moth* (Eudemis botrana).

(b) Eating holes in ripe fruit, beetle large, yellowish, hairy.—*Bumble Flower-Beetle* (Euphoria inda).

(c) Eating holes in young fruit, a long legged beetle.—*Rose Chafer* (Macrodactylus subspinosus).

XV.—Insects Injurious to the Strawberry.

The Roots:

(a) A pinkish caterpillar boring irregular channels through the crown and larger roots, causing them to wither and die.—*Strawberry Root-Borer* (Anarsia lineatella).

(b) A white grub boring downwards from the crown.—*Strawberry Crown-Borer* (Tyloderma fragariae).

(c) A large white grub eating the roots.—*May Beetle* (Lachnosterna fusca).

The Leaves:

(a) Brownish caterpillars in June and August rolling the

leaves into cases and fastening them with silk.—*Strawberry Leaf-Roller* (Phozopteris fragariae).

(*b*) Young plants gnawed off at the surface.—*Cutworms.*

(*c*) Small pale spotted active beetles riddle the leaves with holes in June.—*Spotted Paria* (Paria 6-notata).

(*d*) A small active jumping striped beetle, eating holes in the leaves.—*Striped Flea Beetle* (Phyllotreta vittata).

(*e*) Twenty-legged grubs eating holes in the leaves.—*Strawberry Saw-Fly* (Emphytus maculatus).

The Fruit:

(*a*) A caterpillar feeding on the berry.—*Stalk-Borer* (Gortyna nitela).

(*b*) A minute black bug, producing a buggy odor when eaten with berry.—*Flea-Like Negro Bug* (Corimelaena pulicaria).

(*c*) Flower buds droop and bend over.—*Strawberry-Weevil* (Anthonomus signatus).

Part III.

I.—A CLASSIFICATION AND DESCRIPTION OF COMMON INSECTS.

KEY TO THE COMMON ORDERS OF INSECTS.

A. With two wings; with mouth parts formed for sucking or piercing; metamorphosis complete.....*Diptera* (Flies).

AA. With four wings.

B. Mouth-parts formed for biting.

C. Upper wings horny; metamorphosis complete....
Coleoptera (Beetles).

CC. Upper wings parchment-like; lower wings folded under the upper; metamorphosis incomplete...
Orthoptera (Locusts, etc.).

CCC. Upper wings with many veins.....
Neuropteroida Group (Nerve-winged insects).

BB. Mouth-parts formed for sucking and biting, and wings with few cross veins and similar in texture, metamorphosis complete.....*Hymenoptera* (Bees, etc.)

BBB. Mouth-parts formed for sucking; wings covered with scales; metamorphosis complete.....
Lepidoptera (Butterflies and moths).

BBBB. Mouth-parts formed for piercing; wings either similar (*Homoptera*) or dissimilar in texture (*Heteroptera*); metamorphosis incomplete.....*Hemiptera* (Bugs).

AAA. Wingless.

B. Mouth-parts formed for biting; louse-like insects.

C. Antennæ with many segments.....
Corrodentia (Book-lice).

CC. Antennæ with not more than five segments; metamorphosis incomplete .....
Mallophaga (Bird-lice).

BB. Mouth-parts formed for sucking.

C. Tarsus with a single hook-like claw; with a fleshy unjointed beak; parasitic on mammals (Parasitica) ..... *Hemiptera*

CC. Tarsus 5-jointed; body compressed; metamorphosis complete.....*Siphonaptera* (Fleas).

II.—NEUROPTEROIDA.

The Neuropteroid (or nerve-winged) group of insects includes six main orders, which may be separated as follows:—

A. Lower wings folded in plaits under the upper.

B. Wings covered with hairs; metamorphosis complete.... *Trichoptera* (Caddice-flies).

BB. Wings not covered with hairs.

C. Tarsi 5-jointed; metamorphosis complete..... *Neuroptera* (Dobson-flies, aphis-lions, etc.).

CC. Tarsi less than 5-jointed; metamorphosis incomplete .....*Plecoptera* (Stone-flies).

AA. Lower wings not folded under the upper.

B. Head prolonged into a beak; metamorphosis complete.. *Mecoptera* (Scorpion-flies).

BB. Head not prolonged into a beak.

C. Abdomen with 2 or 3 long filaments; metamorphosis incomplete.....*Ephemerida* (May-flies).

CC. Abdomen without jointed filaments; wings about equal in size; metamorphosis incomplete..... *Odonata* (Dragonflies).

The larvæ of most of the Neuropteroid insects are aquatic and are of litttle economic importance in agriculture.

III.—KEY TO PRINCIPAL FAMILIES OF ORTHOPTERA.

A. Legs similar, fitted for running.....*Blattidae* (Cockroaches). (Running Orthoptera).

AA. Legs similar, slender, fitted for slow walking.....
Phasmidae (Walking sticks. Walking Orthoptera).

AAA. First pair of legs fitted for grasping .....
Mantidae (Praying Mantis). (Grasping Orthoptera).

AAAA. Hind legs stouter or longer than middle pair.....
(Jumping Orthoptera)

B. Antennæ shorter than body.....
Acrididae (Locusts and Short-horned grass-hopper).

BB. Antennæ longer than body.

C. Tarsi 4-jointed.....
Locustidae (Long-horned grass-hoppers).

CC. Tarsi 3-jointed.....*Gryllidae* (Crickets).

1. Blattidae.

Cockroaches.

Several injurious species of cockroaches occur: (1) American Cockroach, (2) Australian roach, (3) Oriental roach, and, (4) German Cockroach or Croton Bug.

(1) *American Cockroach* (Periplaneta Americana), a native species, is a large dark brown insect 1½ inches long, with well-developed wings, 2 inches long; thorax with an obscure yellow border. Eggs held within a capsule until hatched. Duration of life-cycle about a year.

(2) *Australian Cockroach* (Periplaneta australasiæ), 1¼ inches long; resembles preceding but the yellow band on thorax is much brighter and more definitely limited. Upper wings have a dash of yellow on each side. Abundant in the south.

(3) *Oriental Cockroach* (Periplaneta orientalis) or "black beetle," is a nearly wingless, dark brown or black, robust form, about an inch long—the male with wing cases ⅓—½ length of abdomen. Notably gregarious.

(4) *German Cockroach or Croton Bug* (Ectobia Germanica), light brown thorax marked with two dark-brown stripes. Active and wary, relatively small, ½ inch long. All the roaches have a foetid roachy odor. They are said to feed on the Bed-Bug. They

are particularly abundant in pantries, and kitchens, and bakeries. They feed on almost any dead kind of animal matter and cereal products.

Control: See Part IV. [a, b, 6(c)]. A bait of powdered borax mixed with sweetened chocolate; a trap of flour and plaster-paris and water; fumigation with hydrocyanic acid gas.

2. Acrididae.

Grasshoppers (Melanoplus femur-rubrum, and others).

In the West the Rocky Mountain Locust (Melanoplus spretus) did, and occasionally does, produce much injury to grain and other crops. Another species more widely distributed is *M. Atlanis*, which sometimes becomes migratory. In the East the Red-Legged Locust or Grasshopper (M. femur-rubrum), the Two-striped Locust (M. bivittatus) and the Pellucid Locust (Camnula pellucida) in the West are the species that do much injury. The following description applies to the Red-legged species:

Adult.—Brown, medium sized, about 1 inch long, short antennæ, hind legs red.

Eggs.—Deposited in pod-like masses in the ground.

Nymphs.—Vary in size according to age and moult; all stages of developing wings; gray to yellow.

Life History.—Nymphs hatch from eggs in spring; these mature in August and September, when eggs are laid in the ground and over-winter there.

Control.—Use criddle mixture. [See Part IV. (a, b, 6 (c).]

3. Gryllidae.

Snowy Tree Crickets (Œcanthus niveus and nigricornis.)

Adult.—A delicate greenish white cricket; male with wing covers crossed by oblique ribs; female narrower on account of folding of wings about body. August.

Eggs.—Laid in fall, in longitudinal rows of punctures in the canes. Oblong, cylindrical. Hatch in spring.

Nymphs.—Feed on plant lice and other insects; full grown in late July and August.

Control.—Prune out infested twigs and burn.

IV.—HEMIPTERA.

The Sub-Orders and Family Groups of Hemiptera

A. Bugs with a fleshy unjointed beak; wingless; parasitic upon man and other mammals—*Parasita*.

AA. Bugs with a jointed beak; winged or wingless.

B. Beak arising from front of head; first pair of wings thickened at the base with thinner extremeties overlapping on the back—*Heteroptera*.

BB. Beak arising from hinder part of lower side of head; wings of the same thickness throughout—*Homoptera*.

Synopsis of the Heteroptera.

A. *Short-horned Bugs.*—Live in or near water; antennæ short and concealed beneath the head.

Families: Corisidae, Notonectidae, Nepidae, Belostomatidae, Naucoridae, and Galgulidae.

AA. *Long-horned Bugs.*—Antennæ at least as long as the head.

B. *Semi-aquatic Bugs.*—Saldidae, Veliidae, Hydrobatidae, Limnobatidae.

BB. *Land-bugs.*

C. Antennæ 4-jointed.—Emesidae, Reduviidae, Nabidae, Phymatidae, Aradidae, Tingitidae, Acanthiidae, Capsidae, Pyrrhocoridae, Lygaeidae, Berytidae, Coreidae.

CC. Antennæ 5-jointed.—Pentatomidae, Cydnidae, Corimaelinidae, Scutelleridae.

The Economic Homoptera.

A. Tarsi 1 or 2-jointed; antennæ usually prominent; beak apparently arising from sternum.

B. Tarsi 1-jointed; adult male with beak and 2-winged; female wingless with body scale-like, or gall-like, or grub-like, and covered with waxy secretion—*Coccidae* (Scale Insects).

BB. Tarsi 2-jointed; wings usually 4.

C. Wings white, opaque—*Aleyrodidae* (White-flies).

CC. Wings transparent.

D. Legs long and slender; antennæ 3-7 jointed—*Aphididae* (Plant-lice).

DD. Hind legs fitted for leaping; antennæ 9 or 10 jointed—*Psyllidae* (Jumping Plant-lice).

AA. Tarsi 3-jointed; antennæ minute; beak evidently arising from mentum.

B. Ocelli 3; males with musical organs—*Cicadidae* (Cicadas).

BB. Ocelli 2 or wanting; males without musical organs.

C. Antennæ inserted on side of cheek beneath the eyes—*Fulgoridae*.

CC. Antennæ inserted in front of and between the eyes.

D. Prothorax prolonged into a horn above the abdomen—*Membracidae* (Tree-hoppers).

DD. Prothorax not prolonged above the abdomen.

E. Hind tibiæ armed with two stout teeth and tipcrowned with short stout spines—*Cercopidae* (Spittle Insects).

EE. Hind tibiæ having a double row of spines below—*Jassidae* (Leaf-hoppers).

V. KEY TO THE CHIEF ECONOMIC FAMILIES OF THE HETEROPTERA.

A. Antennæ with 3—4 segments.

B. Beak 3-jointed.

C. Front legs with thick femora.....
Phymatidae (Ambush-bugs).

CC. Front legs normal.

D. Antennæ with 3 segments.....
Reduviidae (Assassin-bugs).

DD. Antennæ with 4 segments.

E. Tarsus with 2 segments, body flat...
Aradidae (Flat-bugs).

EE. Tarsus with 3-segments, dorsum flat, beak short.....
Acantidae (Bed-bugs).

BB. Beak 4-jointed.

C. Ocelli absent.

D. Membrane of front wings with branching veins.....*Pyrrhocoridae* (Red-bugs).

DD. Membrane of front wings with no branching veins.....*Capsidae* (Leaf-bugs).

CC. Ocelli present.

D. Membrane of front wings with 4 or 5 simple veins arising from its base.....
Lygaeidae (Chinch-bugs).

DD. Membrane of front wings with many forked veins arising from a transverse basal vein..... *Coreidae* (Squash-bugs).

AA. Antennæ with 5 segments, tibiæ with few spines, body flat.....
Pentatomidae (Stink-bugs).

1. Coreidae.

Squash Bug (Anasa tristis.)

Infests pumpkins and squashes. It is a sucking insect and should not be confused with the cucumber or squash beetle.

Adult.—Dirty blackish brown above and mottled yellowish beneath; ¾ inch long; wings folded diagonally across the back; beak 4-jointed; ill-smelling.

Eggs.—Laid in clusters on the underside of leaves; red or bronze; smooth and shining; hatching in 8—13 days; slightly flattened on two sides; 1-25 inch long.

Nymphs.—At first small green and black bugs like adults but without wings and proportionately longer legs and antennæ. Five moults occur.

Life History.—It hibernates as an adult under rubbish, in outbuildings, etc. In spring the adult injures the young squash plants and also lays eggs; nymphs reach maturity in July. Two broods in [redacted]

(Consult Cir. 39, Div. Ent. U. S. Dept. Ag. and Rep. Ent. Soc., 1900.)

Control—Spray with kerosene emulsion; trap the adults under bits of board; destroy the egg-masses; destroy the vines in fall.

2. Ly[redacted]e.

Lygaeidae

Tarnished Plant Bug (Lygus pratensis.)

This plant bug is a very common insect, feeding on a wide range of food plants.

Adult.—A metallic brown with black and yellow and red markings, but pattern is somewhat variable; ¼ inch long; flattened.

Eggs.—Deposited singly on host plant.

Nymphs.—Probably four or five stages of growth, at first small and yellowish, without wings, then greenish with five black dots on the back and growing wing pads.

Life History.—Hibernates as an adult in sheltered situations; eggs laid in early spring and nymphs appear in May. Broods not yet well distinguished. Insects seen from spring until fall.

Lygaeidae

Chinch Bug (Blissus leucopterus.)

A black bug, ¼ inch long, wings marked by a small black triangle on their outer margins. The bases of the antennæ and the legs are red.

Eggs.—Cylindrical, 3-10 inch long; square at one end; whitish at first.

Nymphs.—Six stages from egg to adult insect. The successive stages show changes in size and markings.

Life History.—Bugs hibernate under rubbish and in clumps of grass. In May and June females lay their eggs on the roots or the bases of the stems. Eggs hatch in 2 or 3 weeks. The nymphs reach maturity in six or seven weeks, when a migration occurs to other plants. Eggs are again laid and the nymphs attain maturity in autumn. There are, therefore, two broods in a year.

Control.—Clean up rubbish; barriers of oil or tar lines; burn meadows; plow.

3. Capsidae.

Four-Lined Leaf-Bug (*Pœcilocapsus lineatus.*)

This bug is one of the most common insects found during summer on field and garden vegetation. It is occasionally destructive in flower gardens.

Adult.—A greenish yellow bug with two black spots on the thorax and four black stripes down the back; 3-10 inch long; abundant in June and July.

Eggs.—White, laid on terminal twigs of currant and other bushes in the fall; hatch in the spring.

Nymphs.—Red when young, but blacker when older. The insects injure the tips of shoots and cause the leaves to curl up and become brown spotted. Currants, gooseberries, mint and sage are especially liable to injury.

4. Coccidae.

Scale Insects.

Scale insects are typically bark-lice, being minute sucking insects covered with a waxy secretion. Some, like the Mealy Bugs, secrete a cottony material; some, like the Lecaniums, secrete a waxy hard continuous layer which forms a protection for the back; while others, like the San Jose Scale and the Oyster Shell Scale, possess true scale-like coverings, composed partly of a waxy secretion and partly of moulted skins, beneath which the insect lives.

For a short time after birth the Scale insects crawl about, but soon they settle on the bark or leaf and begin sucking the sap. After a few moults the females lose their legs, eyes, feelers. The male adult insect is, as a rule, an active 2-winged insect with legs, eyes, feelers, but no mouth. In most species the females lay eggs, but in a few the young scale insects are born alive.

Control.—Spray with lime-sulphur; kerosene emulsion; whitewash. [See Part IV. (a, b, 2, (a), (b), (6).]

Following are the most common economic forms.

(1) *Oyster Shell Scale* (Lepidosaphes ulmi) is one of the most common pests of the orchards. The female scale is oyster-shell shaped, narrow brownish black; male scale smaller and ovate. Yellowish white eggs under the female scale in winter. Eggs hatch in late

May or early June and the larvæ moult twice. The females lay their eggs in October.

(2) *Scurfy Scale* (Chionaspis furfura) occurs on pear, apple, gooseberry and black currant. The scales are white; the female scale is ovate. Purplish colored eggs under the female scale in winter. Eggs hatch about the middle of June and the larvæ moult twice. The male scale is much smaller, and has its sides nearly parallel; there is but one moult. The female lays her eggs in autumn.

(3) *San Jose Scale* (Aspidiotus perniciosus) occurs on orchard trees, bush fruits, and other perennials and annuals. On badly infested branches the scale presents the appearance of dark gray scurfy patches. On fruit there is often a purplish discoloration about the scale. The female scale is circular with a central exuvium; the half-grown scales are black and show a central nipple surrounded by one or two depressed rings. The male scale is oval, twice as long as broad, with a long dark exuvium showing a central nipple situated towards the small end of the scale.

The San Jose Scale winters in the half-grown state. Early in spring the winged males appear, and the females resume growth. In June the females begin to produce living young, and the period of production lasts about six weeks during which time each female produces on an average 400 young. The young females mature in 35—40 days, and the males in about 25 days after their birth. Three closely related species: *A. aneylus* (Putnam Scale), *A. forbesi* (Forbes' Scale), and *A. ostreaeformis* (Curtis Scale) are difficult to distinguish from the San Jose.

An unarmoured type of scale, *i. e.*, where the secretion goes to thickening the back of the insect, is found on plum *Lecanium Cerasifex* (Plum Scale).

(See "San Jose and Other Allied Scale Insects," Toronto, 1900, and Bul. 34 Div. Ent. U. S. Dept. Ag., 1902.)

(4) *Mealy Bugs.*—Green house plants, such at crotons, oleanders, lemons, date palms, ferns, acalyphs, are seldom entirely free from scale insects. Crotons and oleanders are often injured by *Mealy Bugs*, which are mealy in appearance and are able to move about freely. At maturity they secrete a cottony sack within which are deposited the cream-colored eggs.

Lemons, crotons, oleanders, ivies, and ferns are very liable to injury from species of Lecanium and Aspidiotus; *Lecanium oleæ*, *Lecanium hemisphaericum*, *Lecanium hesperidum*, *Aspidiotus ficus* and *Aspidiotus hederæ*.

(See 1880 Rep. U. S. Dep. Ag., p. 334; 2nd, Rep., Que. Soc. Prot. Plants, 1909-1910.)

(5) *Plum Scale* (*Lecanium cerasifex.*)

This scale, also called the New York Plum Scale, is sometimes abundant in plum orchards.

Adults.—Full grown in June. Female scales conspicuous brown objects, "like small halved peas," adhering to branches and twigs. Male scales much smaller, flatter, more elongate, and of a whitish color; male insect emerges in May from scale, delicate, and provided with two whitish wings.

Eggs.—Deposited under scale in early June.

Nymphs.—Emerge from beneath the mother scale, and crawl to the leaves in July; secrete much honey dew; about the end of August they begin to migrate from the leaves to the twigs and branches where they hibernate. In early spring (April) they begin feeding again and grow rapidly; mature in June.

(6) *The Terrapin Scale* (*Lecanium nigrofasciatum.*)

This scale attacks shade trees, such as maple, basswood, birch, and orchard trees, such as apple, plum and peach.

Adult.—Female nearly hemispherical, reddish, 1-7 inch long, mottled, with radiating streaks of black conspicuous about the margin. Male is a minute, delicate 2-winged insect, appearing early in August; male scale smaller than female, elongate, slightly convex, and greenish white.

Eggs.—Deposited in early spring beneath the scale; hatch in June-July.

Nymphs.—Female scales nearly full grown by autumn, and winter as such. Mature early in spring.

There is but one brood each year. A 20-25% kerosene emulsion applied in dormant season destroys the hibernating females.

(7) *Cottony Maple Scale* (*Pulvinaria vitis.*)

This insect occasionally becomes a serious pest of shade trees, such as the soft maple, box elder, basswood, etc.

Adult.—Conspicuous on account of the cotton-like waxy masses projecting from beneath the brown scale of the female. Female scale "elliptical, convex on the back with a low rounded median ridge; pale green or whitish yellow, marked with black or brown."

Male scale winged, with two long caudal filaments, and long antennæ.

Eggs.—Minute, oval, pale yellowish; enclosed in the secretion of waxy threads; 3,000 eggs by each female, in June and July.

Nymphs.—At first active and crawling, with six legs; later they settle and secrete a thin waxy covering on their backs. Females fertilized by the males in late summer. They migrate from leaves to twigs in autumn where they remain all winter.

5. Aphididae.

Plant-Lice.

Plant-Lice are gregarious sucking insects, often abundant on many varieties of plants, and doing much injury. Three forms occur:

1. Sedentary wingless viviparous females;

2. Migratory, winged viviparous females;

3. Sexual males and females—the females wingless and the males winged or wingless.

Most plant-lice excrete a sweet liquid called "honey dew," which is attractive to ants, bees, wasps and other insects. On account of this honey dew aphids are often attended by ants who guard them. Forbes has shown that the little brown ant (Lasius niger) has domesticated the Corn-root Aphis, which is cared for and controlled in all stages of its development.

In general, plant-lice are soft-bodied and green, sometimes brown or black. The winged forms have four delicate wings with a few simple veins; the front pair much larger than the hind pair. The sucking beak is 3-jointed; the legs and antennæ are long and eyes prominent. In autumn the sexual females deposit eggs which hatch in the spring into females, which are often termed "Stem-mothers." These produce living females which in turn produce living females, and so on for several generations. As each female produces several young, and these mature in a short time, reproduction is very rapid. When autumn approaches and food supply is becoming scarce a brood of males and females is produced. The females produce the winter eggs. Sometimes agamic females hibernate. There are many species of plant-lice, some feeding on one variety of plant, but many are capable of feeding on two or more varieties. Some produce abnormal growths called galls, such as the Grape Phylloxera Gall, the Cockscomb Gall on the elm, the Cottonwood Gall, the Poplar Gall.

Control.—Spray with kerosene emulsion, whale oil soap, lime-sulphur, tobacco extract, etc.

(1) *Aphis brassicae* (Cabbage or Turnip Plant-Louse) is often abundant on the under surfaces of leaves of cabbages and turnips, and in warm dry weather becomes very destructive. It is a greenish soft pear-shaped insect covered with a whitish bloom.

(2) *Aphis gossypii* (Melon Plant-Louse) occurs on the under surfaces of the leaves of melon, cucumber, squash, etc. It is a blackish green insect and occurs on other crops and weeds. Winter eggs have been found on purslane and strawberry.

(3) *Aphis rumicis* (Bean Aphis) occurs on the tips of horse and broad beans at time of flowering. When the lice are abundant the plants assume a sooty sickly appearance.

(4) *Apple Plant-Lice.*

(Consult Circ. 81, Bureau of Ent. U.S. Dep. Ag.)

There are two or three species of Aphids feeding on apple twigs and leaves:

(*a*) *Aphis mali Fab., Aphis pomi de G.* (green apple aphis).—Pear shaped, greenish or yellowish green. It causes a curling of the leaves and inhabits the apple throughout the season.

(*b*) *Aphis malifoliae, Fitch, Aphis Sorbi Kalt, Aphis pyri Boyer* (rosy apple aphis).—A larger species with rounder body and usually a rosy color. It also causes a curling of the young leaves. After the third summer agamic generation this species deserts the apple, but returns in the autumn. (Consult "Apple Tree Insects of Maine"; Cir. 81, Bureau of Entomology, U. S. Dept. Ag.)

(*b*) *Siphocoryne avenae Fab.* (European Grain Aphis).—A greenish insect feeding for five generations on apple, in July migrating to grains and grasses, and migrating back in autumn.

(*d*) *Schizoneura lanigera* (Woolly Aphis of Apple).—Existing in two forms, one on the roots, and the other on the lower limbs and water shoots; mostly wingless, of a reddish-brown color and covered (especially in the aerial forms) with a flocculent waxy excretion. On the roots rough growths are produced which interfere seriously with their nutritive functions. Winged females appear in autumn and each produces a single winter egg.

(5) *Myzus ribis* (Currant Aphis).—A small yellowish plant-louse causing a curling and blistering of the leaves of currant with red discoloration of the upper surfaces.

(6) *Myzus cerasi* (Cherry Aphis).—is dark brown in color; eg laid in autumn on branches of cherry at the base of buds and crevices of the bark. Plant-lice most abundant in June.

(7) *Grain Plant-Louse or Aphis (Nectarophora granaria Kby.*— Allied species— N. cerealis Kalt., Siphonophora avenae Tib.

Adult.—The winged forms vary greatly in color, from green wit black legs, feelers, head, cornicles, and spots on side of abdomen spring (17th Report Ill. State Entomologist, Plate C) to yellow reddish or black as the grain matures. Wingless mature forms als occur.

Eggs.—Deposited in autumn on young heat, and hatched ou in spring.

Nymphs.—Usually green, soft-bodied, pear-shaped, sucking i sects, wingless.

Life History.—Eggs are laid in autumn by winged females, an nymphs emerge in spring and feed upon the juices of stems an leaves, and developing kernels. The wingless adults, all females give birth to living young, generation after generation, throughou the summer. The multiplication of generations is very rapid. I autumn a winged brood appears, and the females deposit eggs o the young wint· wheat. Many of the plant-lice are destroyed b parasites.

(8) *Grape Phylloxera* (*Phylloxera vastatrix.*)

Four forms recognized: 1, leaf-gall form; 2, root form; 3, winged form; and, 4, sexual form.

1. Adult leaf-gall form, a wingless female, plump orange-yellow Fills gall with many yellow eggs, which hatch in 8 days into fe males. Several generations during summer.

2. Root form similar to that on leaf; often derived from leaf forms; several generations in a season.

3. Some of the root forms in late summer develop winged fe males that fly to neighboring vines and lay 2-4 eggs beneath loose bark.

4. These eggs are of two sizes—the smaller producing males, the larger sexual females. These are very minute. Each female lays one large egg from which hatch the following spring the leaf and root forms.

Not destructive on sandy soils.

Control.—Spray in early spring with lime sulphur.

6. Psyllidae.

Pear Psylla (Psylla pyricola.)

Adult.—A reddish bug, 1-10 inch long, with blue markings; wings clear with dark veins, and laid roof-like over the body; when disturbed it hops and flies away. Eyes bronzy; hibernates.

Eggs.—Orange-yellow, minute, 1-18 inch long, pear shaped; hatch in 2—3 weeks.

Nymphs.—Broadly oval, flattened, yellowish bodies with crimson eyes; later reddish with black markings and conspicuous black wing pads; secrete honey dew; 4—5 moults.

There are 4—5 generations each year.

5. Membracidae.

Buffalo Tree-Hopper (Ceresa bubalus.)

This bug is a common pest of orchards and shade trees. It injures the trees by making longitudinal incisions in the bark, which become points of weakness.

Adult.—A grass-green bug, ¼ inch long, with the pronotum greatly enlarged, and expanding laterally into two horns and posteriorly into a long point. July-September.

Eggs.—Dirty-whitish, cylindrical, slightly curved, tapering towards outer end; 1-16 inch long. Laid arranged in the bark in batches of 6-12 in two curved slits made by ovipositor. Egg-laying occurs in August and September; hatch following May and June.

Nymphs.—Covered along the centre of the back with numerous forked or barbed projections. General feeders.

(Consult Cir. 23, Div. Ent. U. S. Dep. Agric.)

7. Jassidae.

Grape Leaf-Hopper (Typhlocyba comes.)

This bug is a very common pest in vineyards, and occasionally does considerable injury to the leaves which curl and turn brown. During the summer the nymphs feed on the under surface of the leaves and give them an unnatural spotted appearance. The adults, mature in August, also do much harm.

Adult.—Hibernates as adult in nearby grass and wood-lands, and emerges about May 1st; ½ inch long; wings and back variably marked with yellow and red.

Eggs.—3-100 inch long, semi-transparent, slighty curved, faintly yellow; deposited in June beneath the lower skin of grape leaves; hatch in 9-14 days.

Nymphs.—Light yellowish green with lemon-yellowish stripes on each side of the body; pass through 5 stages.

(See Bul. 215, Cornell Ag. Exp.. St., 1904.)

Control.—Spray thoroughly with tobacco extract or kerosene emulsion when young appear.

8. Acanthiidae.

Bed Bug (Acanthia lectularia.)

Adult.—Reddish brown, ¼ inch or less in length; never fully winged but with wing pads; flattened; hiding in day-time in cracks but active at night; sucking mouth parts; "buggy" odor.

Eggs.—White, oval, 1-20 inch long; laid in cracks and crevices; each female lays about 200 eggs, 50 at a time.

Nymphs.—White at first but after feeding red; resemble adults but body more slender and head larger; 11 weeks to mature; one generation in a season.

Control.—Fumigate with sulphur or carbon bisulphide; wash floors thoroughly with soapsuds and spray with benzine.

9. Pediculidae.

Sucking Lice.

Most domestic animals at some time or other are liable to become infested with sucking lice, which cause considerable irritation. The eggs of "nits" are attached to the hairs and the lice by means of a beak suck the blood of their victims.

Treatment consists in the application of tobacco water, dilute carbolic acid, kerosene emulsion or sulphur ointment.

VI.—LEPIDOPTERA (BUTTERFLIES AND MOTHS).

The Common Families of the Lepidoptera.

A. Antennæ club-shaped at apex; wings at rest held erect; day-fliers.

B. Butterflies with cubitus apparently 4-branched ..... *Papilionidæ* (Swallow-tails).

BB. Butterflies with cubitus apparently 3-branched.

C. Fore-legs normal .....*Pieridæ* (Pierids).

Larva:- 3 pro true legs
6 " pro "

CC. Fore-legs reduced in size .....
Lycænidæ (Gossamer-wings).

CCC. Fore-legs aborted, mere tippets ... .
Nymphalidæ (Four-footed Butterflies).

AA. Antennæ clubbed but terminated by a hook; wings at rest held erect .....*Hesperidæ* (Skippers).

AAA. Antennæ not clubbed at apex; wings at rest held flat or folded like a roof over the body.

B. Hind wings with one or two anal veins.....
(Macrolepidoptera).

C. Frenulum present.

D. Subcosta and radius of hind wings connected by a strong oblique vein .....
Sphingidæ (Hawk-moths).

DD. Subcosta and radius of hind wings not connected by a cross vein.

E. Cubitus of fore-legs apparently 3-branched.

F. Basal part of subcosta of hind wings joined to radius for a distance then bending sharply toward costal margin ...
Geometrina (Geometrids).

FF. Basal part of subcosta of hind not as in F .....
Notodontidæ (Prominents).

EE. Cubitus of fore-wings apparently 4-branched.

F. Subcosta of hind wings either separate from or joined for a short distance to radius.

G. Ocelli absent; antennæ pectinate .....
Liparidæ (Tussock-moths).

GG. Ocelli present; antennæ simple .....
Noctuidæ (Owlet-moths).

FF. Subcosta of hind wings united with radius for a considerable distance .....
Arctiidæ (Tiger-moths).

CC. Frenulum absent.

D. Cubitus of both wings apparently 4-branched.

Hind wings with humeral veins .....
Lasiocampidæ (Tent-Caterpillar Moths).

DD. Cubitus of both wings apparently 3-branched. Tongue absent; tibia without spurs.
Saturniina (Silk-worm moths).

BB. Hind wings with three complete anal veins.

C. Wings transparent; free from scales .....
Sesiidæ (Clear-winged moths).

CC. Wings covered with scales..(Microlepidoptera).

D. Subcosta and radius of hind wings fused or approximate .....*Pyralidina* (Pyralids).

DD. Subcosta and radius of hind legs far apart.
E. Second anal vein of hind wings forked at base.*Tortricina* (Tortricids).

EE. Second anal vein of hind wings not forked at base..*Tineina* (Tineids).

NOTE.—The *Geometrina* includes the following families: Ennomidæ, Geometridæ, Hydriomenidæ, Sterrhidæ and Monoctenidæ. The *Pyralidina* includes the Pyraustidæ, Pyralididæ, Galleridæ, Crambidæ, Phycitidæ. Pterophoridæ and Orneodidæ. The *Tortricina* includes the Grapholithidæ, Conchylidæ and Tortricidæ. Sonsult comstock's manual).

1. Tineidae.

Clothes Moths.

Three injurious species of Clothes Moths are recognized in America, (1) Case-making Clothes Moth, (2) Webbing or Southern Clothes Moth, and (3) Tapestry Moth.

(1) *Case-Making Clothes Moth* (Tinea pellionella), so called because the larva makes a true transportable case.

Adult.—A small tineid moth expanding ½ inch; head and fore wings grayish yellow; hind wings grayish white and silky. June —August.

Eggs.—Minute whitish, placed directly on food material, hatch in about 10 days.

Larva.—A dull white caterpillar with head and upper part of neck segment brown; living within its case; feeds on woollens, carpets, furs, feathers, etc.

Pupa.—Formed within larval case; duration about 3 weeks. One generation a year in the north.

(2) *Webbing or Southern Clothes Moth* (Tineola biselliella).—Two broods in north—but less common than preceding.

Adult.—Fore-wings pale ochreous.

Larva.—It constructs no case, but spins a silky cobwebby path wherever it goes.

(3) *Tapestry Moth* (Trichophaga tapetzella), rarer and rather larger than either of the preceding.

Adult.—Head white, basal half of fore-wings black; outer half creamy and gray; hind wings pale gray. Expanse ⅔ inch.

Larva.—Burrows in food material, lining them with silk—no other protection than the galleries or burrows it makes. Feeds on carpets, horse-blankets, tapestries, felting, furs, skins and woollen upholstering of carriages.

Control.—Give clothes or carpets a thorough beating; spray with benzine and expose to sun for some hours; repeat frequently.

Diamond-Back Moth (*Plutella cruciferarum*).

The caterpillar of this moth occasionally attacks the leaves of turnips and cabbages.

Adult.—A slender moth, of a general ashy-gray color with white diamond-shaped marks on the back when wings are closed; ⅝ inch expanse.

Larvæ.—A minute active caterpillar with spindle-shaped body; a wriggling motion when disturbed; feeds on the lower surface of the leaves; effects visible in July.

Pupa.—In a beautiful white lace-like cocoon on the surface of the leaves; winters as a pupa.

There are probably two broods in a year in Canada.

Palmer Worm (*Ypsolophus pometella*).

Adult.—A minute brownish-gray tineid moth, expanding ½ inch; fore-wings springled with black scales, and marked near middle with 4 black marks; hind wings fringed, dusky. July. Hibernates as adult.

Eggs.—Probably laid in May, and hatch in two weeks.

Larva.—Skeletonizes the leaf; a small caterpillar, ½ inch long; brownish-green; head light brown. Dorsal surface with two lateral and two dorsal whitish stripes. June.

Pupa.—A small brown object attached to leaf by a few silk threads, duration 10 days.

(Consult Bul. 187, Cornell Agric. Exp. St.)

Leaf Sewer (Ancylis nubeculana).

Adult.—A small white tortricid moth with brown markings; wing expanse ½ inch. May—June.

Eggs.—Laid in June.

Larva.—½ inch long; yellowish-green; head yellow; thoracic shield darker with a black dot on each side; each body segment with pale tubercles bearing a single hair. Hibernates as larva in folded leaves on the ground. Full grown in April.

Pupa.—Duration about 10 days. The larva folds the leaf along the mid-rib, and forms its nest within.

Leaf Crumpler (Mineola indiginella).

The larva feeds on the buds in early spring. Matures in late May, and the moth issues in June—July. Eggs are laid in July singly on the leaves and the larvæ feed within a case, enlarging it when necessary. In autumn the half-grown caterpillar fastens clusters of brown shrivelled leaves together with threads of silk and forms a curved tube within. Spray in early spring with arsenate of lead.

Apple Leaf Miner (Tischeria malifoliella).

The larva of this small moth forms trumpet-shaped blotches under the surface of the leaves.

Adult.—A minute moth expanding ½ inch; wings broadly fringed. Fore-legs shining dark brown with a purplish tinge; hind wings gray; head and antennæ dark brown. May.

Eggs.—Small, greenish-yellow, blister-like, elliptical, 1-50 inch long, attached to surface of leaf. Hatch in 8—10 days.

Larvæ.—Miners within the leaf; mature in three weeks.

Pupa.—Pupa formed within the leaf. Duration 8—10 days. Two or three generations each season. Larvæ of last generation hibernate in the fallen leaf.

Apple Leaf Bucculatrix (Bucculatrix pomifoliella).

Adult.—A small moth, ½ inch expanse; fore-wings whitish tinged with pale yellow and dusky brown. Hind wings broadly fringed. Appears when leaves unfold.

Larva.—½ inch long, cylindrical, tapering at both ends; dark greenish-yellow. with reddish tinge on anterior segments, active. Full grown in July.

Pupa.—Cocoons dirty white, slender, ½ inch long; six prominent longitudinal ridges; oblong, tapering at both ends; fastened to twigs in groups, in September—October, etc. Hibernates in this stage.

Case Bearers.

Two species of Case-Bearers are found in apple orchards: the Cigar Case-Bearer, and the Pistol Case-Bearer. They do most injury to the young buds and blossoms.

(1) *Cigar Case-Bearer (Coleophora fletcherella):*

Adult.—A small grayish moth, expanding ½ inch; wings broadly fringed. June—July.

Eggs.—Delicate light lemon-yellow; pitted; cylindrical; laid singly on under sides of leaves; hatch in 10—14 days, about July 15th.

Larvæ.—Orange colored; head black; feed as miners for 2—3 weeks within the leaf, then later in curved cases, on the leaves. About September 15th they migrate to the twigs where they hibernate in their cases. About April 15th they attack the young buds, etc.; about the end of May they make their characteristic cigar-shaped cases, from within which they feed on the leaves. About the end of June they change to pupæ.

Pupa.—Light brown; duration about 10 days.
(Consult Bul. 93, Cornell Ag. Exp. St.)

(2) *Pistol Case Bearer (Coleophora malivorella):*

The life history of this species is very similar to that of the Cigar Case Bearer, the habits of the larvæ differing to a slight extent.

Adult.—A minute moth with brownish, heavily fringed wings and covered with white scales, head and thorax white; abdomen whitish; all parts dotted with brown scales. June—July.

Eggs.—Cinnamon rufous; like inverted tea-cups with strongly ridged sides; July; egg stage lasts about a week.

Larvæ.—Never miners; make cases as soon as they begin to eat. In September they migrate to twigs where they pass the winter in small pistol-shaped cases. In spring they attack the buds and make irregular holes in the leaves. About the beginning of June they change to pupæ.

Pupa.—Pupal stage lasts about 2 weeks.
(Consult Bul. 124, Cornell Agric. Exp. St.)

Control.—Spray in early spring and July with arsenate of lead.

2. Tortricidae.

Oblique Banded Leaf Roller (Cacoecia rosaceana).

Adult.—A yellowish brown tortricid moth with oblique dark bands across the fore-wings; bell shaped with wings folded; hind wings pale yellow. End of June.

Larva.—Caterpillars become partially grown by autumn; they roll up and fasten together the young leaves within which they feed; ¾ inch long; yellowish-green.

Pupa.—A dark brown object formed in its silken shelter in folded leaves.

Control.—Spray with arsenate of lead in early spring and July.

3. Grapholithidae.

Codling Moth (Carpocapsa pomonella).

This insect is the most destructive of apple insects.

Adult.—A small grayish-brown moth, ¾ inch expanse; fore-wings crossed by alternate transverse waxy bands of brown and gray, and with a large dark brown spot in the inner hind angle; hind wings light silky brownish-yellow, darker towards the margin. Flies at night.

Eggs.—A minute thin scale-like white object, at first transparent but later with a blackish streak. Each female deposits 60—75 eggs, deposited mainly on the leaves a week or two after the blossoms fall; hatch in 5—10 days.

Larva.—At first whitish with distinct black tubercles on the body and black head; later the tubercles less distinct. When full grown

larva is ¾ inch long, whitish or pinkish, head brown, tubercles indistinct. Matures in 3—4 weeks. Winters as a larva within a white cocoon.

Pupa.—Pale brown; within a cocoon; duration 10—12 days.

Life History.—Winters as a full grown larva within a cocoon on the trunk, under bark, etc.; about the time of apple blossoming the larva transforms to a pupa, and the moth emerges 10—12 days later. The eggs are laid singly on the leaves, stems, and even fruit, where they hatch in about a week. The young larva feeds a little on the leaves, but finds its way to the fruit which it enters usually at the calyx end. It then makes its way to the core. When full grown in 3—4 weeks it makes its way out of the apple by a round hole and finds a place under bark, etc., to make its cocoon. In Canada, with the exception of Southern Ontario, there is but one brood a year, but further south there are two or even three broods.

(Consult Bul. 142, Cornell Ag. Exp. Sa.; Bul. 41 n. s. Div. Ent. U. S. Dep. Agric.; Bul. 187, Ont. Dep. Agric.)

Control.—Spray with arsenical just after the blossoms fall, again in 3 weeks.

Bud Moth (*Tmetocera ocellana*).

The caterpillar of this moth sometimes does serious injury to the unfolding flower and leaf buds of the apple.

Adult.—A small moth with broad yellowish-white bands across ash-colored fore-wings; ¾ inch expanse; lives 2—3 weeks. Emerges in July and deposits eggs.

Eggs.—Flattened, disk-shaped, transparent; laid singly, or in clusters on the under surface of the leaves; hatch in 7—10 days.

Larva.—Full grown larva ½ inch long, chestnut brown; head, legs, and thoracic shield dark brown or black, smooth and shiny. Full grown in June. Winters as half grown larva in small oval silken cases on bark of twig. Emerges in spring when buds are expanding and bores into the bud and feeds for 6—7 weeks.

Pupa.—A thin closely woven silk cocoon within a tube of leaves. Pupal stage lasts about 10 days.

Life History.—Hibernates as a half-grown larva, and matures in June; pupal stage lasts 10 days and moth emerges in July to deposit eggs. Young caterpillars feed on epidermis of leaf within a silken tube for protection. About first of September they leave their silken tubes and form oval silken cases on the smaller twigs near the buds, where they hibernate.

(Consult Bul. 107, Cornell Agric. Exp. St.)

Control.—Spray with arsenate of lead when buds are expanding, and again when the leaves are expanded.

Pea Moth (Semasia nigricana)

Adult.—A small gray moth ⅜ inch long.

Eggs.—

Larva.—A small whitish slightly hairy caterpillar, about ½ inch long when full grown, feeding within the pod on the green peas.

Pupa.—Small oval cocoons in the ground near the surface.

Life History.—Early in July the moths emerge from cocoons in the ground, and begin egg-laying, larvæ hatch in about 2 weeks. About the end of July the larvæ emerge from the pods and spin small oval cocoons near the surface where they remain all winter.

Control.—Sow early varieties.

Lesser Apple Worm (Enarmonia prunivora).

The work of this worm is similar to that of the Codling Worm. In addition, the young larvæ hatched in August sometimes eat on the surface of the fruit.

Adult.—Ground color of fore wings black with pale rusty red patches, and with gray, yellowish-white and blue oblique lines; hind wings dusky gray at base, shading to black at apex. Appears in July.

Eggs.—Eggs hatch in 4—6 days; minute oval, covered with network of irregular ridges. Deposited on both sides of leaves, but on upper surface of fruit, stems, etc.

Larva.—Full grown larva ½—⅝ inch long; reddish flesh-colored above; lighter below; head brown; thoracic shield yellowish, transparent; anal plate brownish and with an anal fork; mature in June and July. Time in fruit 2—4 weeks; larva in cocoon before pupation 7—8 days.

Pupa.—Pupation in spring; cocoon densely lined inside with whitish silk; pupa—brown, ½ inch long; pupation stage about 10 days.

(Consult Buls. 68, Part V, and 80, Part III, Bureau of Entomology.)

Control.—As for Codling Moth; spray again in August.

Grape Berry Moth (Polychrosis viteana).

Adult.—A purplish-brown tortricid moth, ½ inch expanse; wings leaden-blue with dark spots.

Eggs.—Minute, whitish and scale-like.

Larva.—Mature caterpillar, ¾ inch long, dark green to purplish; head light brown; thoracic shield black; body covered with many faint spots bearing whitish hairs; 3 weeks.

Pupa.—Formed in a thin silk cocoon in a piece of leaf; light greenish-brown. Duration 10—14 days.

Life History.—In early spring moths appear and lay their eggs in the blossoms and on young grapes. The young larvæ feed on the blossoms and young berries, webbing the clusters together. They mature in 3 weeks and pupæ are formed in cocoons made from bits of leaf and lined with silk. Moths emerge in 10—14 days in July. The eggs of second generation laid on the berries; and the larvæ feed on the pulp and seeds. Sometimes there is a third generation. Winter is passed in the pupal stage.

Control.—Spray with arsenate of lead and a sticker (1) just before blooming, (2) just after, and (3) in July, when the berries are half-grown.

4. Sesiidae. (Clear Wing Moths)

Peach Tree Borer (*Sanninoidea exitiosa*).

The Peach Tree Borer is a native insect and occurs wherever peaches are grown east of the Rockies.

Adult.—A slender dark blue clear winged moth, wasp-like. Male moth with wings transparent and bordered with steel blue; expands 1 inch. Female moth with fore-wings blue and clothed with scales; hind wings transparent resembling the male; a broad orange band about middle of abdomen; expands 1⅛ inches. July—September.

Eggs.—Minute, oval, yellowish-brown; and hexagonally sculptured; truncate at one end; deposited on the bark near surface of ground. Each female may lay from 200—300 eggs; hatch in about 10 days.

Larvæ.—One inch long when full grown, robust, yellowish-white with head and first segment white. Young larva bores into sapwood at or below surface of ground, and continues feeding well into the fall and after hibernating resumes feeding in spring, reaching full growth from July 1st—September. Exudation of gum mixed with bits of bark and excrement.

Pupa.—Cocoon-like cell elongated, made of grass and bits of bark attached with gum and threads of silk. Duration about 3 weeks. But one generation each year.

(Consult Cir. 54, Div. of Ent., U. S. Dep. Ag.; Bul. 170. Cornell Ag. Exp. St.)

Control.—Prot r cut out the caterpillar in fall or early spring; mounding up the earth about base of tree in spring; protect trunk with paper or wire covering or netting.

Imported Currant Borer (Sesia tipuliformis).

Adult.—A small clear-winged moth, ¾ inch expanse; body black with a yellow band about the neck, and three yellow bands across the tufted abdomen; fore-wings with a margin of blackish scales and a band about ⅓ from the tip. June.

Eggs.—Small, brown, globular; placed in axils of leaves, or in cracks of the canes.

Larva.—Bores into pith of cane and makes a long black tunnel in it; when full grown ¾ inch long, yellowish; head brown; numerous tubercles on body. Half grown by winter; and hibernates at bottom of burrow; full grown in May.

Pupa.—Pupates in tunnel. Adult emerges in June.

Control.—Cutting out and burning the old and affected canes in fall or early spring.

5. Notodontidae.

Hand-Maid Moths (Datana).

Several species of Datana occur on orchard and forest trees.

(1) *Yellow Necked Caterpillar* (Datana ministra).—The larvæ are gregarious, and are often injurious to the leaves of apple in late summer.

Adult.—A russet-brown moth; head and large spot on the thorax chestnut brown; fore-wings crossed by 3—5 darker brown lines; hind wings pale yellow.

Eggs.—In regular clusters of 70—100 on surface of leaf; white and round.

Larva.—Caterpillar 2 inches long; head large and black; cervical shield dull orange; back and sides striped alternately with black and yellow lines; body thinly clothed with soft white hairs. Larvæ occur in clusters and at rest their bodies assume a characteristic bow-form. At maturity they descend to the ground and burrow to a depth of 3 inches. Larval stage 5—6 weeks.

Pupa.—A naked brown pupa in the ground. Moths emerge in July.

(2) *Walnut Caterpillar* (Datana integerrima) is often destructive on walnut, butternut, and hickory, and also on oak, beach, apple, and hawthorn.

Adult.—A buff-brown moth with darker bands across the fore-wings.

Eggs.—Laid in clusters of 100 or more.

Larvæ.—Caterpillars feed in clusters devouring the leaves; when nearing maturity they separate. Body black, with a loose covering of soft whitish hairs; when at rest they assume a bow-habit. When mature they descend and enter the earth.

Pupa.—A dark brown chrysalis; hibernates in this stage.

Control.—Spray caterpillars with arsenical.

6. Geometridae.

Spring Canker Worm (Paleacrita vernata).

Adults.—Male moth with thin brownish-gray silky wings, 1 inch expanse; fore-wings with a row of light markings near outer margin and three transverse dark irregular bands; female moth wingless, ½ inch long, dull gray or brown with a dark brown stripe down the middle of the back. April.

Eggs.—Yellowish-green, oval, 1-35 inch long; laid in irregular masses of about 50 under loose bark, in crevices. Hatch in a month about the time of unfolding of the leaves.

Larvæ.—Slender, cylindrical, 1 inch long, with only two pairs of pro-legs with narrow longitudinal pale lines, and a whitish stripe along each side. Mature in 4—5 weeks, when they drop to ground and enter it to a depth of 2—5 inches.

Pupa.—Cocoon lined with silk in earthen cell; pupa remains in it until following spring; light brown and pitted. Male pupa spined.

Fall Canker Worm (Alsophila pometaria).

Adults.—Male moth has darker, stronger wings than that of the spring Canker Worm; fore-wings crossed with two light bands, and hind wings are darker. Female moth wingless, ashy-gray, no markings, long antennæ. October—November.

Eggs.—Brownish-gray, flower-pot like, outer end with a dark spot surrounded by a dark ring. Laid in clusters of 100, in rows,

each egg fastened on end and to the bark. Hatch in May, about the time of unfolding of the leaves.

Larva.—Resembles in a general way that of Spring Canker Worm, but has a broad dark stripe along the back; three pairs of pro-legs near hind end of body. Enters the ground and forms a cocoon. Matures in 4—5 weeks.

Pupa.—Cocoon tough and contains more silk; pupa stouter and spine of male pupa forked.

Control.—Spray with arsenate of lead; band trees with burlap in fall.

Currant Span Worm (Cymatophora ribearia).

Adult.—A pale yellowish geometrid moth with brownish spots, 1½ inches expanse; wings variable and often with one or two cross bands. Mid-summer.

Eggs.—Laid on twigs about July; hatch the following spring when leaves are full grown.

Larva.—Full grown in 3—4 weeks; yellow and black spotted loopers.

Pupa.—Formed just beneath the surface of ground; duration 2—3 weeks. One brood each season.

Control.—Spray with arsenical or pyrethum.

7. Noctuidae.

Cutworms.

(Consult Bul. 95, Ill. Agric. Exp. Station, 1904.)

There are many species of cutworms that feed upon economic plants. They are mostly "plump, soft-bodied, cylindrical caterpillars, dirty grayish or whitish, and variously spotted and striped" (Forbes). They are the larval stages of species of Noctuid moths, commonly termed "millers," and are night feeders. "They are essentially grass and clover insects, and by far the greater part of them are bred in pastures and meadows."

Control.—Part IV (T, a (c) and b, 6.)

The following species are most commonly met with:

Noctua C-nigrum (Spotted Cutworm).—With 2 rows of triangular black spots on the back; pale brown or gray; 1½ inches long. Active in April and early May on garden vegetables. Two broods.

Noctua clandestina (W-marked Cutworm).—With 4 rows of dark spots and often also with lighter lines along the back. Active in April and May in gardens.

Agrotis ypsilon (Greasy Cutworm).—With a faint dull dirty yellow stripe along the back; dark greasy gray in color, and greenish-yellow below; 1½ inches long. Most active in May and early June on corn and garden vegetables.

Peridromia saucia (Variegated Cutworm).—Variable in color, but with a row of 4 dots extending half way down the back, and a velvety spot on the segment next to the last. Ground color is grayish or brownish. Active in May and early June in gardens.

Hadena devastatrix (Glassy Cutworm).—Translucent whitish tinged with bluish-green and without spots; head reddish-brown; neckshield brownish. Active in May and early June, and on hay and garden vegetables.

Hadena arctica (Yellow-headed Cutworm).—Pale smoky gray, with head and neck shield tawny-yellow; without spots. Active into July on cereal crops and vegetables.

Euxoa messoria (Dark-sided Cutworm).—With a dark stripe on each side of the ashy-gray body. Active in May and June on fruits and garden vegetables.

Euxoa ochrogaster (Red-backed Cutworm).—With a broad red stripe down the back; body gray or dull brown; active in May, June and July on corn.

Nephelodes minians (Bronze Cutworm).—Large, 1½ inches long, with alternate stripes of olive-bronze and yellowish, a pale stripe along the middle of the back, and two others on each side. Active in grass lands in April and May.

Mamestra picta (Zebra Caterpillar).—"Velvety black on the back; beautifully ornamented with two golden-yellow stripes on each side of the body, which are connected by narrow lines of the same color; the head and feet reddish-brown" (Fletcher). Two broods, on cabbages and turnips.

Life History.—The majority of the species hibernate as partly-grown larvæ, and enter the ground to pupate in late June and early July. The adults—usually grayish nocturnal moths—emerge in early August and lay their eggs in grass lands. The larvæ that hatch from these eggs feed on the roots of grasses until winter sets in.

Climbing Cutworms.

Some species are known to have a climbing habit. Among these (Bul. 104, Cornell Ag. Exp. St., 1895) are:

White Cutworms (Carneades scandens).—1¼ inches long, yellowish-gray with whitish spots; spiracles black.

Spotted Legged Cutworm (Posoragrotis vetusta).—1½ inches long; black spots in legs; feeding on peach buds.

Dingy Cutworm (Feltia subgothica).—Common; with wide buff-gray dorsal stripe; head and thoracic and anal shields dark brown. Feeds on garden crops.

Loopers.

Cabbage Looper (Plusia brassicæ).—Larva is a looper and feeds on cabbage and related plants.

Adults.—A "miller" moth brownish-gray; front wings transversely mottled with gray, white and black, and bearing a small silver-white spot on inner half; expanding 1½ inches; borders of wings scalloped.

Egg.—Silvery-white, semi-globular, with radiating vertical ribs.

Larva.—A pale green translucent looping caterpillar, obscurely marked longitudinally; prolegs absent from 6th and 7th segments.

Pupa.—Invested in a white gauzy silken cocoon spun on any convenient object.

Life History.—Probably two broods in a year in Canada.
(Consult Bul. 33, Div. Ent., U. S. Dep. Ag., 1902, pp. 60—69.)

Celery Looper (Plusia simplex).—Slightly larger than the preceding species.

Adult.—A "miller" moth with fore-wings marked with gray and seal brown, silver mark hooked; wings expanded 2 inches; borders not scalloped.

Egg.—Milky-white, flattened, globular; upper half grooved vertically.

Larva.—A pale yellowish-green looping caterpillar; markings similar to those on P. brassicæ; supra-spiracular spots black.

Pupa.—Resembles that of P. brassicæ.

(Consult Bul. 33, Div. Ent., U. S. Dept. Ag., pp. 73—74.)

The Army Worm (*Leucania unipuncta*).

Adult.—A dingy yellowish brown moth with a white spot on the centre of each front wing.

Eggs.—Minute white eggs laid in strings.

Larva.—A dark colored cutworm, 1½ inches long; back striped with black and yellow lines; under surface greenish.

Pupa.—A brown chrysalis in the ground.

Broods.—There are usually three broods of the Army Worm Moth each season. The insects pass the winter as half-grown caterpillars. In the spring these mature, change to pupæ and the moths appear early in June. The May brood of caterpillars seldom do much harm. The female moths lay their eggs (about 700) on grass leaves from which caterpillars hatch in about ten days. It is also the caterpillars of this brood that do so much injury. The worms usually feed at night, consequently whole fields may be ruined before they are discovered. This July brood of caterpillars reach maturity in about 25 days, change to pupæ in the ground, and the moths appear again in about two weeks. These again lay eggs for a brood of worms, which appear in September, but these are seldom injurious.

Control.—Plowing the fields in late fall; plowing three or four furrows in front of the advancing army and killing the worms that fall into the furrows; poisoning a narrow strip on the threatened side of field with Paris green or the poisoned bran mash.

Corn Ear Worm (*Heliothis armigera*).

Adult.—An ochre yellow moth with blackish markings, expanding about 1½ inches.

Eggs.—Small yellow circular flattened disks, prettily corrugated by ridges radiating from the centre.

Larva.—Variable in color, pale green or brownish caterpillar, 1½ inches long, often dark striped; head amber-yellow; legs black.

Pupa.—In a small oval cell in the ground.

Life History.—In Canada there is one brood, perhaps two in some southern localities. The insect hibernates as a pupa. The moth emerges the following July, when eggs are laid on the silk of the ears. The young caterpillars feed upon the young kernels until fully developed, when they descend to the ground and transform to pupæ in small oval cells. This insect is known in the south as the Cotton Boll Worm.

Stalk Borers.

Several species of Stalk Borers are injurious to various cultivated plants, such as hop vines, columbines, corn, potatoes, tomatoes, raspberries, aster, dahlia, and on burdock. The caterpillar lives inside the stem and makes a burrow by devouring the interior. As a result the plant often withers and dies. Before maturity it works its way down to the root where it changes to pupa. They have been placed in the Genera Gortyna, Hydroecia and Papaipema. Gortyna immanis occur on hop vines; Papaipema purpurifascia in columbine; P. nitela in corn, dahlia, aster, potatoes, etc., and P. cataphracta in burdock.

The caterpillar of P. nitela is about 1¾ inches long, flesh colored and with 4 longitudinal brown stripes; transforms to pupa in its burrow in the stalk or in the ground, pupal stage lasts 2—4 weeks and the moth emerges in September. Moth is mouse-gray in color with a light band on each fore-wing. Clean cultivation is necessary for its control.

8. Liparidae.

Gypsy Moth (Porthetria dispar).

Adult (male).—A brownish yellow slender moth with feathered antennæ; fore-wings marked with zigzag darker lines; wing expanse 1½ inches; an active flier.

Adult (female).—White, with slender black antennæ; body so heavy as to prevent flight.

Eggs.—In irregular oval spongy masses of 400—500 on convenient objects and covered with tan-colored hairs. Laid in July—August, and hatch about May 1st following.

Larva.—A dark brown hairy caterpillar 2—3 inches long; 2 rows of red spots and 2 rows of blue spots along the back with a dim yellowish stripe between; body clothed with long black hairs. Full grown about July 1st.

Pupa.—Cocoon loosely formed among the leaves; pupa conical and dark brown. 1 inch long.

Life History.—Winters in the egg state; eggs hatch about May 1st and the caterpillars are full grown about July 1st, requiring 9—11 weeks to complete their growth; largely nocturnal; the pupa stage is short and the moths appear throughout July. The larva feeds on a very large variety of plants—forest, orchard, and shade trees, shrubs, and even herbaceous plants.

Brown Tail Moth (*Euproctis chrysorrhœa*).

Larva destructive to orchard, shade, and forest trees.

Adult.—A white moth, except that the abdomen is tinged with brown and tipped with a tuft of brown hairs, most conspicuous in the female. Both sexes are strong fliers and active at night in July.

Eggs.—In brownish clusters of 150—300 on the leaves on the tips of the branches. Usually brown hairs are mixed with the egg mass. Eggs hatched by August 15th.

Larva.—Dark brown caterpillar 1½ inches long with a sprinkling of orange; body covered with fine reddish-brown hairs; a row of conspicuous white hairs along each side; bright red tubercles on top of 6th and 7th abdominal segments. Full grown in June. Winter is spent as black quarter grown larvæ in colonies or nests of leaves bound firmly together by a silken web. Barbed hairs irritating to human skin.

Pupa.—Loose cocoon attached to leaf; pupa brown, about ¾ inch long.

Control.—Gathering the winter nests; poisoning the caterpillars; parasites.

White Marked Tussock Moth (*Hemerocampa leucostigma*).

Adult.—Male winged; ashen-gray in color; fore-wings crossed by wavy bands of a darker shade, with a minute white crescent near outer hind angle, a small black spot near tip of outer edge and an oblique blackish stripe beyond it.

Antennæ broad and feather-like.

Female wingless with slender antennæ, and of a light gray color.

Eggs.—White and nearly globular; 300—500 arranged in a 3 or 4 layered mass and covered with a frothy substance.

Hatch in May or early June.

Larvæ.—1¼—1½ long, bright yellow; head and two small protuberances on hinder portion of back bright coral red; four creamy tufts on back; two black plumes at front and one at the rear; black and dusky yellow stripes along the back and sides.

Pupa.—Cocoons made of silk and hairs; pupa brownish, the male smaller than the female; 10—15 days.

Life History.—Eggs are laid in July and August and hatched in May or early June; caterpillars full grown in a month; pupal stage lasts about two weeks, and the adults emerge in July and August to lay their egg-masses.

But one brood in Canada and Northern United States.

Control.—Collect and destroy the egg-masses; spray in June with arsenical; band trees with burlap or tar to prevent females from ascending.

9. Arctiidae.

Woolly Bears.

Several interesting and common caterpillars may be conveniently grouped as "Woolly Bears," on account of their hairy appearance. A few of these are here considered:

1. *Yellow Bear* (Spilosoma Virginica).—Color of caterpillar variable; frequently yellow or straw color with a black interrupted line along each side of back, and a black transverse line between each segment; hairs long and yellow; uneven in length and not gathered into pencils. Cocoon is light and composed of hairs in which pupa passes the winter. Moth is snowy-white; wings marked with a few black dots; three rows of black spots on abdomen.

2. *Hedge-Hog Caterpillar* (Pyrrharctia isabella).—An "evenly clipped furry caterpillar, reddish-brown in the middle and black at either end." Passes winter as larva. Moth (Isabella Tiger Moth) has wings and body orange-buff, hind wings tinted with rose. Body with 3 rows of black dots.

3. *Salt Marsh Caterpillar* (Estigmene acræa.)—Body and head blackish with pale longitudinal stripes on the back; hair is dark brown; passes winter as pupa. Moth has abdomen orange and wings white in female, and hind wings orange in male; both marked with black dots. Six rows of black spots on abdomen, one on back, one on venter, and two on each side.

4. *Fall Web Worm* (Hyphantria textor).—Conspicuous by their webs or nests in autumn on orchard, shade and forest trees.

Adult.—Quite variable in markings; pure white, sometimes spotted with black; expands 1¾ inches.

Eggs.—Laid in a flat cluster of about 400 on under side of a leaf; golden-yellow, globular and pitted; hatch in about 10 days.

Larvae.—When young pale yellow with two rows of black marks along the body, head black; hairs sparse; and when full grown they are covered with long whitish hairs arising from black-yellow warts; one inch long; spin webs.

Pupa.—Cocoon of silken web interwoven with hairs; pupa dark brown. Winter passed as pupa.

Life History.—Hibernates as a pupa under rubbish, in crevices, under walls, etc. Moths emerge in spring, in May and June; eggs hatch in about ten days and caterpillars mature in August and September.

Control.—Prune off and burn the webs; spray with arsenical; collect and destroy the cocoons.

5. *Hickory Tiger Moth* (Halisidota caryæ).—The caterpillar feeds on hickory, butternut, apple and other trees. It is covered with tufts of white hairs, has a row of 8 black tufts on the back, and two long slender black pencils on the 4th and 10th segments; head, feet, and under surface of body black; upper surface of body white with black dots.

10. Lasiocampidae.

1. *Orchard Tent Caterpillar* (*Malacosoma Americana*).

Frequently a serious defoliator of orchard trees.

Adult.—A brown moth expanding 1½ inches; fore-wings crossed obliquely by two pale lines; female larger than male.

Eggs.—A glistening brown mass (200—300— encircling the twigs. Each end of belt of eggs tapers.

Larva.—A hairy black soft velvety caterpillar, 2 inches long, with a white stripe down the back; on each side a row of blue spots; sides streaked with white or yellow lines; under side blackish. Caterpillars of a colony form silken tents at angles of branches and feed away from tents. Matures in 4—5 weeks.

Pupa.—Cocoons formed under bark, in crevices, etc., elongated oval; outer silk delicate and loose, inner part firm and close; a yellow powder within. Pupa stage lasts 2—3 weeks.

Life History.—Winters in the egg state; eggs hatch in May and the caterpillars reach maturity in June. Adults appear and eggs are laid in July. There is but one brood each year.

2. *The Forest Tent Caterpillar* (Malacosoma disstria) differs from the preceding in the following particulars: Egg mass nearly square at the ends; caterpillars do not construct tents; line along the back is broken with dots; transverse lines on the wings of moth are darker than ground color.

Control.—Destroy the egg masses; spray caterpillars with arsenical; burn off the tents; band trees with burlap or tar to prevent the caterpillars from ascending.

VII.—COLEOPTERA (Beetles).

The Chief Groups of Beetles.

A. Head not prolonged into a narrow beak of the ordinary form.. *True Beetles.*

B. Tarsi of the same number of segments.....*Isomera.*

C. Fourth and fifth tarsal segments not grown together..... *Pentamera.*

D. First three ventral segments grown together; most with thread-like antennæ.. *Carnivora* or *Predaceous Beetles.*

DD. First ventral segments not grown together.

E. Antennæ clubshaped..... *Clavicornia* or *Club-horns.*

EE. Antennæ serrate ..... *Serricornia* or *Saw-horns.*

EEE. Antennæ lamellate..... *Lamellicornia* or *Leaf-horns.*

CC. Forth and fifth tarsal segments grown together; antennæ bead-like..*Phytophaga* or *Plant-eaters.*

~~BB.~~ Tarsi 3-jointed.....(*Trimera*) *Coccinellidae.*

BBB. Fore and middle tarsi 5-jointed and hind tarsi 4-jointed. *Heteromera.*

AA. Head prolonged into a beak....*Rhyncophora* or *Snout-beetles.*

Chief Families of the Carnivora:

A. Legs adapted for running; terrestrial, antennæ 11-jointed.

B. Antennæ inserted on front of head above the base of the mandibles..... *Cicindelidae* (Tiger-beetles).

BB. Antennæ inserted on sides of head between the base of the mandibles and the eyes..... *Carabidae* (Ground-beetles).

AA. Legs adapted for swimming; aquatic.

B. With only two eyes.....*Dytiscidae* (Diving beetles).

BB. With four eyes.....*Gyrinidae* (Whirligig-beetles).

Chief Families of the Clavicornia:

A. Legs fitted for swimming; aquatic..... *Hydrophilidae* (Water-scavengers).

AA. Legs not fitted for swimming; terrestrial.

B. Elytra short.....*Staphylinidae* (Rove-beetles).

BB. Elytra as long or nearly as long as body.

C. Abdomen with 5 ventral segments.....
Dermestidae (Larder-beetles).

CC. Abdomen with 6 or more ventral segments.....
Silphidae (Carrion-beetles).

Chief Families of the Serricornia:

A. Head inserted in thorax up to eyes.

B. First two segments of abdomen fused together on ventral side.
Buprestidae (Metallic wood-borers).

BB. First two segments of abdomen not fused.....
Elateridae (Click-beetles).

AA. Head not inserted in thorax up to eyes.

B. Wing covers flexible (*Lampyridae*.)

Chief Families of the Lamellicornia:

BB. Wing covers firm. (*Cleridae*)

A. Antennæ elbowed; lamellae fixed....*Lucanidae* (Stag-beetles).

AA. Antennæ not elbowed; lamellae not fixed.....
Scarabaeidae (Leaf-chafers).

Chief Families of the Phytophaga:

A. Body and antennæ short.

B. Front of Head prolonged into a broad, graduate, beak; elytra short; seed eaters..*Bruchidae* (Pea-weevils).

BB. Front of head not prolonged into a beak; elytra long; leaf-eaters..... *Chrysomelidae* (Leaf-beetles).

AA. Body and antennæ long..*Cerambycidae* (Long-horned beetles).

Chief Families of the Heteromera:

A. Head with distinct neck; body soft and elytra flexible.....
Meloidae (Blister-beetles).

AA. Head without distinct neck; body wall hard.....
Tenebrionidae (Darkling beetles).

Chief Families of the Rhyncophora:

A. Dorsum of last segment of male divided transversely; mandibles without scar on ..... *Curculionidae* (Curculios).

AA. Dorsum of last segment of both sexes undivided.

B. Dorsum horizontal; tibiae serrated..... *Scolytidae* (Bark-beetles).

BB. Dorsum vertical; tibiae not serrated..... *Calandridae* (Granary-weevils).

1. Dermestidae.

Buffalo Carpet Beetle (Anthrenus scrophulariae.)

Adult.—A stout oval beetle, ⅛ inch long, with black, white, and red mottled wing-covers. Winters normally out of doors, under bark of trees and other shelters. In spring it visits spiraeas, cherries, etc.

Eggs.—Laid in convenient places on the carpet or other woollens. Hatch in a few days.

Larva.—A stout active grub, ¼ inch long, covered with stiff brown hairs, forming tufts at the sides and at the end of body. Develops rapidly, but may be retarded by cold weather or by lack of food. Normally there are six moults; and feeds on woollens.

Pupa.—Yellowish, formed within a larval skin.

Two generations in the north.

Black Carpet Beetle (Attagenus piceus.)

Adult.—A small black oval beetle, larger than the Buffalo Carpet Beetle.

Eggs.—White, broadly oval.

Larva.—A reddish-brown active grub, ¼ inch long, with a long bushy tail of reddish hairs; body cylindrical with closely appressed hairs.

Pupa.—Duration 10—15 days.

A museum pest; a house pest feeding on woollens. Probably requires 2 years for life cycle.

Raspberry Byturus (Byturus unicolor).

Adult.—A small brown dermestid beetle, 1-7 inch long; body covered with pale tawny hairs. May-July. Feeds on young leaves and buds.

Eggs.—Not observed, but probably laid in June.

Larva.—A small white plump cylindrical grub, ¼ inch long; each segment marked crosswise with a broad yellow band, and many short white hairs. Feeds on heads bearing the berries.

Pupa.—Formed in an earthen cell in the ground; yellowish. Winters as pupa.

2. Elateridae.

Wireworms.

Several species of wireworms are injurious to the roots of cereal crops. Perhaps the most common are Agriotes mancus, Drasterius elegans, Asaphes decoloratus, Melanotus communis.

Adults.—Slender oval hard beetles, the "click" or "snapping" beetles, with serrated antennæ, mostly brownish in color, sometimes black or grayish, or even metallic. In *Agriotes mancus* the "wheat wireworm," the thorax is very convex, and coarsely and densely punctate, and the front or clypeus convex. It is dull brownish yellow, dusky beneath, and sparsely pubescent. *Diasterius elegans* is dull reddish brown, sparsely pubescent, head black, a median black spot on thorax, a black spot in front of middle of each wing cover, and a black cross bar near the apex. *Asaphes decoloratus* is shining black, about half an inch long with divergent hind angles of thorax. *Melanotus communis* is about ½ inch long, dully brown, and with a more or less distinct median impressed line on basal half of thorax.

Larvæ.—Slender, cylindrical, yellowish or reddish brown, wire-like grubs, mostly vegetable feeders, in the ground; more than an inch long when full-grown. Require two or three years to reach maturity. The grub of *Agriotes mancus* is cylindrical pale brownish-yellow with two black pits on last segment, which tapers gradually to a brown point.

The grub of *Diasterius elegans* is one of the smallest wireworms, ½ to ¾ inch long, of a light waxy yellow color. The last segment has has an acute apical notch, is nearly flat, and roughish above.

The grub of *Asaphes decoloratus* is above ¾ inch long, has an oval shaped apical notch on last segment; dark waxy yellow.

also Cryptohypnus p. 71, Dima [illegible]

also Corymbites, Sesachus [illegible]
[illegible]

The grub of *Melanotus communis* is smooth and shining and of a light brown color; last segment ends in a blunt tubercle.

(See Cornell Bul. 33 for descriptions of wireworms.)

Pupa.—A soft white body resembling the adult in form.

Life History.—The full grown larvæ change to pupæ in the soil in July and August. These again become adult beetles in about a month. These beetles remain in the ground until spring in their pupal cells. On emerging they lay their eggs in grass lands in the earth. It is probable that the larval stage of most species lasts two years.

Control.—See Part IV. (I. a). Fall-plowing and a systematic rotation of crops.

3. Buprestidae.

Flat-Headed Apple-Tree Borer (Chrysobothris femorata.)

Adult.—A dark flattened metallic-brown, Buprestid beetle, ½ inch long; wing covers parallel, thin, tapering to a point behind, under surface greenish-blue, under surface of body coppery-bronze. June.

Eggs.—Yellowish, ribbed, 1-50 inch long; deposited in crevices of the bark, often several together; hatch in days.

Larva.—Light yellow, one inch when full grown; thorax broad and flattened; and abdomen flattened and often curved. Head small and concealed by thorax; tunnels formed immediately under the bark, sometimes girdling the tree. Matures in a year and winters as a full grown larva.

Pupa.—Yellowish; duration about 3 weeks, in spring.

This borer attacks shade and forest trees as well as orchard trees, and is of common occurrence. It attacks unhealthy trees by preference.

4. Scarabaeidae.

White Grubs (Lachnosterna spp.)

White grubs are the larvæ of May Beetles, the majority belonging to the genus Lachnosterna. The following species: L. fusca, L. rugosa, L. tristis, and L. ilicis are perhaps the most abundant.

Adults.—Robust, pale-reddish, or yellowish brown to piceous lamellicorn beetles, with long dense hairs on the sternum; about ¾ inch long.

Eggs.—Oblong oval, white, translucent about $\frac{1}{8}$ inch long, deposited singly from one to three inches below the surface of the soil. They hatch in about 2 weeks.

Larvæ.—Large, soft, white grubs with brownish heads. Hinder portion of body thick and smooth.

Pupæ.—Whitish forms in oval cells.

Life History.—The eggs are laid in May and June; the grubs feed throughout the next season, and in June or July of the third year they change to pupæ. Two or three weeks later they change to adult beetles but remain in their pupal cells until the following spring. In other words, larvæ hatched in June, 1909, change to pupæ in July 1911, and the beetles emerge in May and June, 1912. During the winter the grubs descend for protection.

Control.—See Part IV. (I, a). T.

Rose Chafer (*Macrodactylus subspinosus.*)

This insect is frequently injurious to grapes, peaches, plums, roses, etc., by destroying the blossoms and newly set fruit.

Adult.—A long-legged yellowish-brown beetle, $\frac{1}{2}$ inch long, covered with light hairs; legs spiny and long; end of June—first half of July. Feeding for 3—4 weeks.

Eggs.—Laid singly (24-36) a few inches below the surface of the ground; hatch in 2—3 weeks.

Larva.—Yellowish-white with a pale brown head; $\frac{3}{4}$ inch long when full grown; white grub-like; matures in autumn and hibernates in the ground. Larvæ feed on the roots of grasses in sandy areas.

Pupa.—Pupa stage entered in spring and lasts for 10—30 days. (Consult Cir. 11, Div. Ent. U. S. Dep. Ag.)

5. Chrysomelidae.

Colorado Potato Beetle (*Leptinotarsa 10-lineata.*)

Adult.—A robust ochre-yellow beetle with ten black longitudinal lines on wing covers.

Eggs.—Orange, oval, laid in clusters of 12 or more on the lower surface of leaves; hatching in a week.

Larvæ.—At first dark colored; later, variegated red, soft bodied, hump-backed, with two rows of spots on each side; mature in 4 or 5 weeks.

Pupa.—Naked, yellow or orange colored, in an oval cell below the surface.

Life History.—Adult beetles emerge from their winter quarters about the end of May, and soon eggs are deposited. The grubs require 4 or 5 weeks to mature, and the pupa remains about 2 weeks in the soil before the adult appears. There are probably three broods in a year, the second developing in a shorter time than the first. The third brood emerges in September and passes the winter under cover. There is also considerable overlapping of stages and broods on account of variation in times of development.

Control.—Spray with arsenical.

Striped Cucumber-Beetle (Diabrotica vittata.)

Destructive to squash, melon, and cucumber, both in the adult and larval stages, especially in early spring.

Adult.—A yellow beetle ⅛ inch long, with a black stripe on each side of each wing cover; head black; under surface mostly black.

Eggs.—1-40 inch long, lemon to orange in color, oval; laid singly or in groups in the soil about the roots. Hatch in 9—10 days.

Larva.—A slender white worm-like grub with head thoracic and anal plates dark brown; lives in the soil and lasts about a month.

Pupa.—Formed in earthen cells 2—3 inches below surface; ¼ inch 1—2 weeks.

Life History.—Probably has two broods in a year. The adults hibernate under rubbish, etc., but appear again in April or May. They attack cucurbits when set out and eggs are deposited. Beetles of the second brood appear in July.

(Consult Cir. 31, Bureau of Ent. U. S. Dep. Ag., 1909.)

Control.—Keep vines well covered with Bordeaux; use trap squashes; place cheese-cloth screens over plants.

Grape Root Worm (Fidia viticida.)

Adult.—A small brownish beetle, ¼ inch long; covered with whitish hairs; body stout and legs long; June—July.

Eggs.—Whitish-yellow, cylindrical, 1-25 inch long; laid in masses of 25—40, beneath old bark; hatch in 9—12 days.

Larvæ.—Young grubs feed on roots and become nearly full grown by fall. Winter deeper in the soil. Resume feeding in spring. Full grown grub ⅜ inch long, whitish. July—June.

Pupa.—Formed in earthern cells 2—3 inches below surface; ½ inch long; whitish; head, thorax, and tip of abdomen pinkish and spiny. Duration about 2 weeks in June.

Control.—Spray with arsenate of lead and molasses in late June and early July; stir the soil in June.

Asparagus Beetles (Crioceris asparagi and C. 12-punctata.)

Steel-Blue Asparagus Beetle (C. asparagi):

Adult.—A small beetle ¼ inch long, blue-black; thorax red; wing covers yellow and black with orange margin.

Eggs.—Dark brown, oval, 1-16 inch long, laid on end on the stems of leaves in a row in early spring; hatch in 3—8 days.

Larva.—Head and legs black; dark gray or olive; ½ inch long, soft, fleshy and wrinkled; matures in 10—14 days.

Pupa.—In a rounded earth-covered cocoon in the ground just beneath the surface; beetle emerges in a week.

Twelve-Spotted Asparagus Beetle (C. 12-punctata):

Adult.—Wings orange-red with 12 black spots.

Eggs.—Laid singly on side; laid mostly near the ends of old shoots.

Larva.—3-10 inch long; head brownish and body yellowish.

Pupa.—As in C. asparagi.

Control.—Allow chickens the run of the patch; keep all asparagus cut down except the marketable shoots and cut these every day or two; allow some shoots to grow as traps and spray these with arsenate of lead; dust air-slacked lime over the plants while wet with dew.

Flea-Beetles.

(Consult Bul. 19 and 33, U S. Dep. Ag., Div. Ent., and 211, Maine.)

Flea Beetles are minute beetles belonging to several genera of the Chrysomelidae family. They are leaf feeding insects, and are characterized by the large femora of the hind legs, which enable them to leap like fleas.

The following species are the most injurious to cultivated plants:

(1) *Epitrix cucumeris* (Potato Flea-Beetle).—The adult often injuring the leaves of potato, tomato, cucumber, etc.

Adult.—A shining black minute beetle, 1-15 inch long; antennæ and legs reddish-yellow; hind femora pitch black; thorax sparsely punctate; covered with short fuscous hairs; emerges in April and May; again from July—September.

Eggs.—Laid on roots of food plant in June and July.

Larva.—A slender whitish grub feeding on the tubers and roots; 3 weeks.

Pupa.—In small cells about the roots.

Life History.—Adult beetles hibernate under rubbish, emerge in spring to lay eggs and to attack the leaves. Probably two or more broods.

Control.—Keep leaves covered with Bordeaux.

(2) *Phyllotreta vittata* (Turnip Flea-Beetle).—Also called the "Turnip Fly," frequently injurious to the seed leaves of turnips and radish in June.

Adult.—Active shining black beetles, 1-10 inch long; each wing cover with a wavy yellow stripe; femora black; tibæ and tarsi brownish yellow; 5th joint of antennæ broadened.

Larva.—A slender white grub, ¼ inch long, feeding on the roots of cruciferous plants.

Control.—Dust the plants with a mixture of 1 lb. Paris green and 20 lbs. land plaster on first appearance of "fly."

(3) *Systena frontalis* (Red-headed Flea-Beetle).—Injures grape, gooseberry, sugar beat, horse bean, potato, clover, and other plants.

Adult.—Shining black, with a red head; punctations on wing covers dense but not coarse; ¼ inch long.

(4). *Haltica chalybea* (Grape Vine Flea-Beetle).—The early adults injure the buds of grapes and virginia creeper, while the larvæ and late adults riddle the leaves.

Adult.—A polished steel-blue, or sometimes purplish flea-beetle, 1-6 inch long; antennæ and legs brownish black or piceous; thorax distinctly wider at base.

Eggs.—Orange colored, long oval; laid in crevices of the bark near base of buds, or on the leaves.

Larva.—Lightish brown, 3-10 inch long; head black; 6—8 shining black dots on each segment; a brown hair on each dot, legs black; orange colored pro-leg on last segment.

Pupa.—Dark yellow in a smooth oval cell in the ground.

Life History.—Adults hibernate under rubbish, and feed in April on the buds. Eggs deposited in May and hatch in a few days. Larvæ present in May—June and mature in 2—3 weeks; pupæ remain in the earth for 1—2 weeks, and transform to beetles in June —July. There is but one brood.

(Consult Bul. 157, Cornell Ag. Exp. St., 1898.)

Control.—Spray early on the first appearance of the beetles in April with arsenate of lead (3 to 4 lbs. to 40 gals. of water).

6. Bruchidae.

Pea Weevil (Bruchus pisorum)

Adult.—A small brownish black beetle, ¼ inch long, with characteristic black and white markings; sides of thorax notched; abdomen projects beyond the wing covers. Two black spots on uncovered portion of abdomen; antennæ 11-jointed; hind femora thickened and pro-legs with two spines.

Eggs.—Yellow, 1-20 inch long, spindle-shaped.

Larva.—White, fleshy, wrinkled grub, about ¼ inch long when fully grown; 3 pairs of minute legs.

Pupa.—White, becoming brown after threshing or fumigating; thorax with notched sides.

Life History.—Adults winter over and eggs are laid on the forming pods. The larva bores through the wall of the pod and enters the seed, where it feeds and grows. The pupal stage lasts about a week Mature adults develop in August, the majority remaining in the mature seed all winter. Several grubs may inhabit a single seed.

Control.—Fumigate peas with carbon bisulphide.

Bean Weevil (Bruchus obtectus.)

Adult.—A small brown beetle, about ¼ inch long, with wing-covers shorter than the body, and "marked with ten impressed and dotted longitudinal lines which are broken up into pale yellow dashes and dark brown spots" (Fletcher); body covered with short silky hairs; tips of abdomen, antennæ and legs of a reddish tinge; antennæ enlarging towards the tip.

Eggs.—Cylindrical, oval, gray objects, 1-50 inch long, laid on or in the young pods, or stored beans.

Larva.—A small whitish fleshy wrinkled grub.

Pupa.—White and delicate enclosed in an oval pupal chamber.

Life History.—The larva enters the seed, where it feeds and grows until autumn when it changes to a pupa, and a little later to the beetle. Propagation may take place for several generations in the dry beans.

7. Cerambycidae.

Round-Headed Apple-Tree Borer (Saperda candida.)

This beetle is a common pest of the apple, quince and pear in orchards east of the Rocky Mountains.

Adult.—A pretty beetle, ¾ inch long, with long gray antennæ; gray legs; silvery white head and under surface of body; upper surface light yellowish-brown and with two longitudinal white stripes extending through thorax and wing-covers. Appears mostly in June and July.

Eggs.—Embedded singly in incisions in the bark, and covered with gummy substance; pale rust-brown, oval, ⅛ inch long; hatch in 2—3 weeks.

Larva.—Full grown larva is a yellowish fleshy cylindrical legless grub, ¾—1 inch long; head small and dark; body tapering from the thorax backward. Matures in three years. Works in bark and sapwood the first year, bores deeper in the second year, and in the third year bores upward into the solid wood and outward to the bark, and in May of the fourth year transforms to a pupa.

Pupa.—Lighter than larva, with transverse rows of minute spines on the back. Adults appear in June and July. Duration about 3 weeks.

(Consult Bul. 74, New York State Museum.)

Control.—Probe or cut out grubs; apply alkaline wash in early June to trunks.

Raspberry-Cane Borer (Oberea bimaculata.)

Adult.—A slender black Cerambycid beetle, ½ inch long; prothorax yellow, with two or three black spots; antennæ long, and body cylindrical; June.

Eggs.—Large, elliptical, yellow. Egg placed in pith of tip of cane in a slit between two ring-like cuts about an inch apart. Hatches in a few days.

Larva.—A dull yellow grub with a small dark-brown head, 1 inch long; body cylindrical and segments connected. Burrows downward in the pith, often opening at surface of stem. Hibernates near base of stem as a larva.

Pupa.—Formed in burrow in spring. Perhaps this insect requires two years to complete its stages. Wilting occurs in July—August.

8. Meloidae.

Blister Beetles.

(Consult Bul. 43, Div. Ent. U. S. Dep. Agric., 1903, and Bul. 10, Ill. Agric. Exp. St., 1900.)

Five species of Blister Beetles of economic importance are found in Canada:

(1) *Black Blister Beetle* (Epicauta Pennsylvanica) uniformly black and ¾ inch long; the "Aster Bug" of the florists; serious pest of garden vegetables and flowers; occurs from June to October.

(2) *Gray Blister Beetle* (Epicauta cinerea) uniformly gray; a pest of beets and leaves; occurs in July and August.

(3) *Striped Blister Beetle* (Epicauta vittata) ¾ inch long, with four black stripes on back; the "old-fashioned potato-bug"; a general feeder; occurs from June to September; eggs laid on plants or upon the ground.

(4) *Margined Blister Beetle* (Epicauta marginata) of a general black color except that the wing-covers are margined with gray; a general feeder; occurs from July to October.

(5) *Ashy-Gray Blister Beetle* (Macrobasis unicolor) uniformly ashy-gray; feeds on beets, potato and legumes; occurs in June and July.

Blister Beetles are characterized by a long cylindrical soft body and flexible wing covers, by a rounded head joined to a small thorax by a slender neck. As adults they are leaf-feeders, and are gregarious. As larvæ they feed on the egg-masses of grasshoppers and are, therefore, beneficial. These larvæ, on hatching from the eggs, are long-legged and active (the triungulin stage), and on moulting it assumes the second stage (caraboid) with short legs and relatively smaller head. After another moult it assumes the third stage (scarabaeoid), and with the fourth moult is formed the

coarctate larval stage (winter stage). In the spring another moult occurs before the pupa stage is entered.

9. Curculionidae.

Plum Curculio (Conotrachelus nenuphar.)

This insect is a native, and is a most serious pest of plums, apples and peaches.

Adult.—A stout snout beetle, ¼ inch long, brownish, and marked with gray and black; four black ridged tubercles on the wing cover; hibernates and emerges just before the fruit buds open. Feeds to some extent on the buds, but mostly on the young fruit as soon as it is set. Female begins to lay eggs in the young fruit as soon as formed. Lives about 2 months laying 100-300 eggs.

Eggs.—Oval, white, laid in cavities made by the snout of the beetle; egg protected in the hole by a crescent-shaped slit. Hatches in 4—6 days. Deposition occurs mostly in June but continued through July and August.

Larvæ.—Whitish footless grubs, mature in about 20 days; bore out of the fruit and enter the ground.

Pupa.—White; formed in a small cell 1—2 inches below the surface; duration about 23 days; first adults emerge about 10 weeks after the apple blossoms.

Life History.—The insect hibernates as a beetle under rubbish, etc., and emerges early to feed on buds, etc.; eggs deposited in young fruit; larvæ tunnel in the fruit for about 20 days, then enter the ground to pupate; pupa stage lasts about 4 weeks; adults emerge to puncture the ripening fruit, and begin hibernation about first frosts. Larvæ are only in apples that have fallen. Punctures produce gnarling of fruit. The beetles that emerge during the summer deposit no eggs.

Apple Curculio (Anthonomus quadrigibbus).

Is sometimes injurious. The adult beetle may be distinguished from the Plum Curculio by the following characters: (1) more reddish brown; (2) snout is much longer and borne directly in front of the head; (3) wing covers bear four prominent humps; (4) abdomen is more robust; (5) crescent-shaped mark absent. The life-history is much the same as that of the Plum Curculio, except that the pupal stage lasts about a week. The beetles feed but little after they emerge in summer. The larva is a hump-backed, footless white grub, ¼ inch long.

(Consult Bul. 98, Ill. Ag. Exp. St.; Cir. 120, Bureau of Ent., U. S. Dep. Ag.)

Control.—Spray with lead arsenate (3 lbs. to 40 gals.) just after the blossoms fade, and at intervals of ten days; gather promptly fallen fruit; jar the trees and collect beetles.

Clover Leaf Weevil (Phytonomus punctatus).

Adult.—"A stout, oval, brown, finely punctured curculio," about ⅛ inch long; pro-thorax narrower than abdomen; beak about 1½ times as long as the head, stout and curved.

Eggs.—Yellow, oval and pitted.

Larva.—A green, footless grub with a brown head, and a whitish stripe edged with black-red, along the middle of the back, tapers to each end; lies curled in the ground.

Pupa.—Cocoon is oval and the pupa has "a yellowish-green head, small black eyes, and a dark green abdomen."

Life History.—There is but one brood a year. It winters as a partially grown larva. In spring it resumes its growth, and reaches maturity in June. The pupal stage beneath the surface does not last long, and the adult beetles emerge in June and July. The eggs are laid in September and October, and the grubs are partially grown when winter comes.

Dr. Fletcher states that the *Green Clover Weevil* (Phytonomus nigrirostris) is "much more abundant and more destructive to clover in Canada than the Clover Leaf Weevil."

Strawberry Weevil (Anthonomus signatus).

Adult.—A small weevil, 1-10 inch long, from black to dull red, marked with a dark spot on each wing-cover. Snout half as long as body, slender and curved. Hibernates July—May.

Eggs.—Laid in buds in spring; hatch in 6—7 days.

Larva.—Feeds on pollen and harder parts of buds. Matures in 3—4 weeks.

Pupa.—Formed in a cell in the bud; duration 5—8 days. Injury is done also when egg is laid. Then the female cuts the stem of the bud.

(Consult Cir. 21, U. S. Dep. Ag., Div. Ent.)

Strawberry Crown Borer (Tyloderma fragariae).

Adult.—A small dark snout beetle, ⅛ inch long; head and thorax black; each wing-cover with 3 black spots. Hibernates.

Eggs.—Not observed but probably laid in the crown.

Larva.—Small white grub mining out interior of the crown; ½ inch long; legless; head yellowish brown. Matures in August.

Pupa.—Formed in the larval cavity. Adults emerge in late summer and fall.

Scolytidæ.

Fruit Bark Beetle (*Scolytus rugulosus*).

This small beetle, also called the Shot Hole Borer, injures fruit trees by puncturing the bark, and burrowing in the bark and wood, causing the death of twigs and leaf buds.

Adult.—A small black scolytid beetle 1-10 inch long, with the tips of wing covers and parts of the legs red. May.

Eggs.—Deposited in little pockets in the brood gallery or chamber.

Larva.—Matures in three weeks. A minute legless grub, whitish, head small, larger in front than behind.

Pupa.—Pupa formed in a lightly enlarged chamber, duration—a few days. Adults make their way out through little round holes in the bark.

Life Cycle.—About a month; several generations in a season. Said to attack preferably unhealthy trees.

Control.—Remove and destroy dead or dying trees; apply a protective wash of whitewash and carbolic acid in June and August.

Clover Root Borer (*Hylastinus obscurus*).

Adult.—A small dark brown cylindrical hairy scolytidid beetle, 1-10 inch long; wing covers coarsely punctate.

Eggs.—Minute, white, elliptical and shining.

Larva.—A white stout footless grub with yellow head and brown mouth parts; ¼ inch long.

Pupa.—White, with a pair of spines at top of head, and another at tip of abdomen.

Life History.—There is but one brood each year. The adult winters in the clover roots, and lays her eggs during May and June in the crown or on the sides of the root. The larvæ tunnel the root, and mature in July; the pupae transform to adults before October 1st.

VIII.—DIPTERA (FLIES).

The Chief Sub-Orders of Flies.

A. All three thoracic segments fused; usually winged; under lip unsegmented.

B. Adults not parasitic; maxillæ covered by upper lip.

C. Antennæ long, with more than five joints ..... *Nematocera.*

CC. Antennæ short usually 3-jointed and anal cell narrowed .....*Brachycera.*

BB. Adults parasitic; upper lip enveloped by maxillæ as by a sheath .....*Pupipara* (Sheep-tick, etc.).

AA. The three thoracic segments separate; no wings; under lip segmented .....*Siphonaptera* (Fleas).

Key to the Chief Families of the Nematocera:

A. A distinct V-shaped suture on back of thorax..... *Tipulidæ* (Crane-flies).

AA. No V-shaped suture on thorax.

B. Veins and margin of wings fringed with scales ..... *Culicidæ* (Mosquitoes).

BB. Margin of wings not fringed with scales.

C. Anal veins wanting; Vein V. wanting; tibiæ without spurs ....*Cecidomyiidæ* (Gall-gnats).

CC. Anal veins present and Vein V. at least represented by a fold.

D. Abdomen slender; wings narrow; antennæ plumose in the males; wing veins strong near costal margin ..... *Chironomidæ* (Midges).

DD. Abdomen short and thick; wings broad; antennæ short and non-plumose ..... *Simulidæ* (Black-flies).

Key to the Chief Families of the Brachycera:

A. Antennæ of four or five segments, the third joint being ringed.

B. Alulets large and third joint without a style or bristle.. *Tabanidæ* (Horse-flies).

BB. Alulets small; branches of radius crowded together near the costal margin .....*Stratiomyiidæ* (Soldier-flies).

AA. Antennæ of four or five segments but the third joint not ringed.

B. Antennæ long, clavate, apparently 4-jointed; branches of radius curving towards costal margin ..... *Midaidæ* (Midas-flies).

AAA. Antennæ of three segments.

B. Radius four-branched.

C. Vertex of head hollowed out between the eyes; palpi present .....*Asilidæ* (Robber-flies).

CC. Vertex of head not hollowed out; alulets small; beak prominent .....*Bombyliidæ* (Bee-flies).

BB. Radius three-branched.

C. With a spurious longitudinal vein between Radius and Media; front convex between the antennæ *Syrphidæ* (Flower-flies).

D. With rudimentary mouth parts; palpi wanting .....*Œstridæ* (Bot-flies).

CC. With well developed mouth parts; palpi present; head with a suture above the antennæ ..... *Muscinæ* (The Muscids).

D. Alulets small; eyes not contiguous; thorax without complete transverse suture .... *Acalyptrate Muscids.*

DD. Alulets large; eyes often contiguous; thorax with complete transverse suture.. *Calyptrate Muscids.*

E. Cell Radius V. closed or more or less narrowed at the margin of the wing.

F. Antennal bristle bare ..... *Tachinidæ* (Tachina-flies).

FF. Antennal bristle bare near tip. *Sarcophagidæ* (Flesh-flies).

FFF. Antennal bristle pubescent or plumose [illegible] the tip.

G. Abdomen [illegible] bristly... *Dexiidæ*

GG. Abdomen not bristly. except at tip
Muscidæ.

EE. Cell Radius V. widely open .....
Anthomyiidæ (Root-Maggot flies).

1. Tipulidæ.

Meadow Maggots (Crane Flies).

Adult.—Large mosquito-like flies with very long thin legs, long slender bodies, narrow wings and thread-like antennæ. A transverse V-shaped suture on the back of middle portion of the thorax.

Larva.—When full grown about an inch long, dirty brown, and footless; of a tough leathery texture; cylindrical; tapering in front and blunt behind.

Pupa.—No puparium; occupying small cells near the surface of the ground in a vertical position.

Broods.—There are two broods each season. Larvæ winter over and change to pupae in late May. Adults soon appear and deposit eggs from which hatch the maggots. These change to pupae and adults in September when eggs are laid for a fall brood. The maggots hatching from these eggs winter over.

Control.—Early fall plowing, draining, and rotation of crops.

2. Culicidæ.

Mosquitoes.

This family includes several important economic genera, comprising many hundreds of species. The more important of these are Culex pipiens, C. pungens, Anopheles maculipennis, and Stegomyia fasciata.

House Mosquito (Culex pipiens).

Adult.—A slender bodied, delicate fly with gauzy wings, the veins bearing minute scales; deep yellowish to dark brown; legs and beaks not banded; abdomen with narrow whitish bands at the base of each segment. Hibernates as adult. Female bites.

Eggs.—Laid at night or early morning on the surface of standing water in masses of 50 to 400. Hatch in about 24 hours.

Larva.—Large head with a pair of mouth brushes, and a tube at opposite end of body for breathing, not over four times as long as broad; antennæ of moderate length with a branch about middle, bearing a tuft of hairs. Full grown in a week; dirty white, or yellowish.

Pupa.—Hunched object, floating just below the surface. Duration 1 to 3 days.

Number of broods limited only by conditions.

Malarial Mosquito (Anopheles maculipennis).

Adult.—Differs from Culex in being much larger, more slender, with larger legs; wings longer, and more or less spotted with brown or black, and carried flat on the back when not in use; palpi or mouth feelers as long as the beak in both sexes. (In Culex palpi short in female.)

Eggs.—Laid singly on surface of water; hatch in 24 to 48 hours.

Larva.—Larva lies flat on surface; tube very short; at first black or gray usually banded with white, later color harmonizes with surroundings. Full grown in 7 to 10 days.

Pupa.—Like that of Culex but with shorter, more trumpet-shaped breathing tubes; duration about 2 days.

Other species of Anopheles are: A. punctipennis and A. crucians. Responsible for transmission of malaria.

8. Cecidomyiidae.

Hessian Fly (Cecidomyia destructor).

Adult.—A small dusky 2-winged fly, ⅛ inch long, about half the size of a common mosquito; the female larger than the male; legs long and wings smoky black.

Eggs.—Spindle-shaped, reddish and 1-50 inch long.

Larva.—A footless maggot, clear white except for a greenish stripe down the middle; last stage of larva passed in "flax-seed" covering, and has a peculiar "breast-bone," a horny forked organ.

Pupa.—Pupa case deep rich brown like small "flax-seeds"; pupa rosy colored, with a pointed beak.

Broods.—Two generations in fall wheat regions, and one in spring wheat regions. Female lays a few to 50 or more eggs on upper surface of leaf about last week in August and first week in September; maggots hatch in about 4 days and move down the leaf

to the stem where they embed themselves within the leaf-sheath. In about 3 weeks they change to "flax-seed" but remain as larvæ until the following May, when they change to pupæ. The flies emerge a few days later to lay their eggs for a new spring brood on the leaves of spring cereals. The maggot stage lasts until the third week in June, and the "flax-seed" stage until the third week in August when the flies emerge.

Control.—Late seeding in fall on well prepared seed-bed; trap-strips; destruction of "flax-seeds" at threshing; co-operation. (See Part IV. (A. a, (c).)

Clover Seed Midge (*Cecidomyia leguminicola*).

Adult.—A minute 2-winged fly, 1-12 inch long, with red abdomen and long reddish brown legs and antennæ; head and thorax black; wings transparent with dusky hairs.

Eggs.—Very minute, orange, smooth and transparent. Laid in green flower-heads.

Larva.—A footless maggot, orange colored and 1-10 inch long.

Pupa.—Cocoon is oval, 1-12 inch long, made of silk threads; pupa is pale orange; eyes brown; two short tubercles on front of head.

Life History.—There are two broods each year. Eggs are laid in May in the forming flower-heads. At tthe end of June and early July the maggots mature and drop to the ground to pupate. The adult flies emerge when the second crop of clover comes into bloom, and lay their eggs among the blossoms. The maggots leave the ripe heads in autumn, and pass the winter in the ground. In May the adult flies emerge to lay their eggs.

Control.—Cutting or pasturing clover before the 20th June.

Clover Leaf-Midge (*Cecidomyia trifolii*).

Adult.—Smaller than Clover Seed Midge, but very similar in color and markings. Abdomen is darker, due to the large dorsal bands of black scales.

Eggs.—Soon becoming orange in color, cylindrical and slightly curved; very minute, and several eggs usually placed together.

Larva.—White at first, orange later; 1-25 inch long.

Pupa.—Cocoon oval and about 1-15 inch long; pupa is orange, has blackish eyes and a darker median ventral stripe.

Life History.—Probably four broods, each brood requiring about a month.

Wheat Midge (Diplosis tritici).

Adult.—A minute orange-yellow fly 1-10 inch long, smoky-tinged on the back above the wings.

Eggs.—Minute, cylindrical eggs, pale red, in crevices of wheat heads.

Larva.—A short oval orange-yellow maggot, 1-12 inch long.

Pupa.—Pupa cases small, about the size of a mustard seed, in the ground.

Broods.—At the end of June the adult flies lay their eggs in the crevices of the wheat head; the eggs hatch in about a week, and the larvæ feed on the milky juices of the developing kernels for about 3 weeks; they descend to the ground and form minute puparia in the ground, where they remain until the following June. There is but one brood a year.

4. Syrphidae.

The Syrphids or Flower-flies are most valuable parasites of many injurious forms of insects. They are usually bright colored and they feed upon the pollen and nectar of flowers. Their maggots are often found in colonies of plant-lice, upon which they feed. Some syrphid larvæ live in filth and are known as "rat-tailed maggots."

5. Oestridae (Bot-flies).

Warble Fly (Hypoderma lineata).

Adult.—A hairy fly resembling a dark colored bee; ½ inch long, with yellowish white hairs; abdomen banded above with black and whitish stripes; thorax with four prominent lines.

Eggs.—Attached in spring and summer to hairs by a peculiar clasping base; 1-25 inch long; dull yellowish white; narrow; ovoid.

Larvæ.—Full grown maggot, grayish-white, nearly an inch long. Licked into mouths of cattle, and passing by way of gullet to the tissue just beneath the skin of the back. There they form swellings called "warbles", and there they mature. The Bot or maggot stage lasts 9 or 10 months. When mature the maggots bore their way out and drop to the ground and bore an inch or so below the surface, where they can change to pupæ. Four stages of larva.

Pupa.—Puparium dark brown.

Horse Bot Fly (*Gastrophilus equi*).

Adult.—A large brownish hairy bee-like fly, ¾ inch long; wings with dark spots or bands; abdomen brown with spots and conical. July—August.

Eggs.—Yellow, conical, attached to hairs of fore-legs, shoulders and under side of body; 1-16 inch long; hatch most readily 3—4 weeks after deposition.

Larvæ.—Licked into the mouth of the horse, thence into the stomach, where they attach themselves to the wall. Remain in stomach 8—10 months. In spring they escape in the droppings to the ground and bore an inch or two below the surface, where they pupate.

Pupa.—Duration 30—40 days.

Sheep Bot Fly (*Oestrus ovis*).

Adult.—A dull yellow fly a little larger than house fly covered with minute spots; abdomen with five rings, velvety and variegated with dark brown and straw color. Antennæ small, eyes purplish-brown; ocelli three on top of head; no mouth; wings transparent, extending beyond body; winglets large covering the poisers. June—August.

Eggs.—Deposited in nostrils of sheep; hatch almost at once.

Larvæ.—Maggots work their way up the nasal passages until they reach the frontal sinuses, cavities between and above the eyes. There they attach themselves and feed on the mucus present. Young—creamy-white, with two brown spots, spiracles on last segment. Full grown maggot is darker, particularly posteriorly; two small hooks on head; small rounded spots on sides of each segment. When mature maggot passes down the nasal passages and falls to the ground, which it enters to pupate.

Pupa.—Puparium smooth, hard, and black, tapering towards head; duration 40—50 days.

6. Oscinidae.

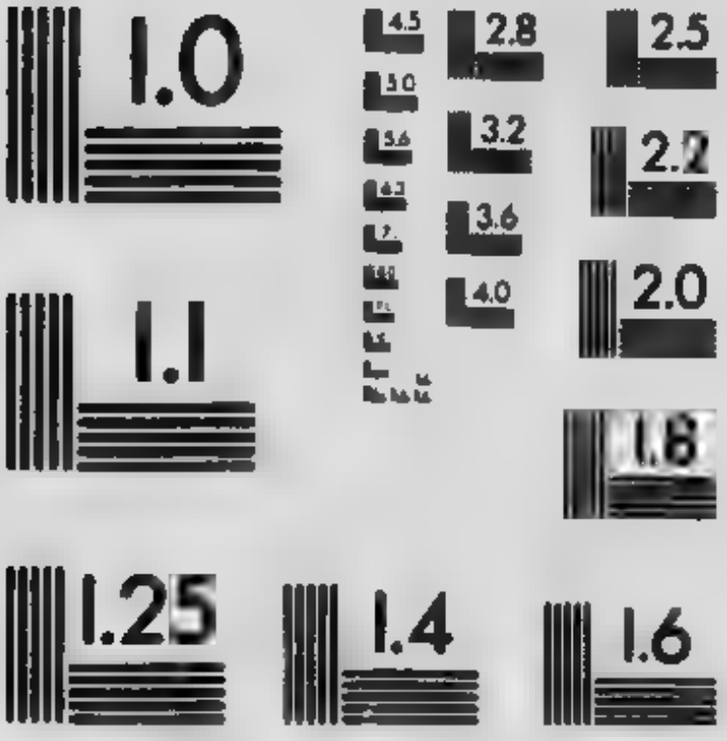
Wheat Stem Maggot (*Meromyza Americana*).

Adult.—A slender 2-winged fly, yellowish-green, ⅛ inch long, with 3 dark stripes running down the back; femora of last pair of legs abnormally developed; eyes golden-green.

Eggs.—About 1-40 inch long, and glistening white.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No 2)



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Larva.—A watery-green footless maggot, ¼ inch long, tapering towards front end and broader posteriorly.

Pupa.—Pupa-case translucent pale green; pupæ greenish and ¼ inch long.

Broods.—Probably there are three generations each season. The eggs are laid in September—October on fall wheat The maggots eat down into the stem where they remain all winter. In early spring they assume the pupal stage, and about the first of June the adult flies appear. This brood matures about August last, when flies again appear. This third generation matures at the end of September and the beginning of October, when the adult flies escape to lay their eggs. Besides wheat, rye, and barley, and oats, this insect attacks timothy, couch grass, elymus,] oa, and green foxtail.

Control.—Grain stacked or threshed; straw stacked or burned; burning of stubble when practicable.

American Frit-Fly (Oscinis carbonaria).

Adult.—Black or yellowish fly, resembling a minute house fly, 1-15 inch long.

Larva.—A yellowish-white slender maggot with two distinct hook-like jaws and two knob-like processes on the last segment of the body; 1-12 inch long.

Pupa.—Pupa-case cigar-shaped and pale chestnut brown.

Broods.—Similar in life history to Wheat Stem Maggot. The larva destroys the centre of the young shoot at the ground in the autumn.

7. Psilidae.

Carrot Rust Fly (Psila rosæ).

The larva of this dipterous insect frequently does considerable injury to carrots in Canada.

Adult.—¼ inch long, dark green, sparsely clothed with yellow hairs; eyes black, and head and legs pale yellow.

Eggs.—Deposited by female about roots of host through cracks in the ground (Ormerod).

Larva.—Maggot dark brown, 3-10 inch long, slender, truncate at posterior end; segments well marked, head small.

Pupa.—Puparium dark brown; anterior segment obliquely truncate; ¼ inch long; pupation in the earth.

Life History.—(Consult Fletcher's Reports and Bul. 33, U. S. Div. Ent.) Winters as larva or pupa; adults appear early in the season; summer generations develop in three or four weeks. (Curtis); both flies and maggots found throughout the warmer months; number of broods uncertain.

Control.—Spray the carrots four or five times at intervals of a week or ten days with kerosene emulsion, the first application at the time of thinning; spread the earth in which carrots have been stored in the poultry yard; sow late and practice rotation of crops.

8. Trypetidae.

Cherry Fruit Fly (Rhagoletis cingulata).

This fly is a close relative of the Apple Maggot, and its larva causes injury to the fruit of cherry.

Adult.—A small fly, ¼ inch long, expanding ⅝ inch; body blackish; sides of thorax marked with yellow band; wings crossed by four blackish bands; abdominal segments marked with whitish cross bands; head and legs pale yellowish brown. June—August,

Eggs.—Deposited under the skin of fruit; hatch in a few days.

Larva.—¼ inch long, similar to apple maggot. Feeds on flesh. When full grown maggot leaves the cherry.

Pupa.—Puparium is formed just beneath the surface of the ground or rubbish. Hibernates as pupa.

Apple Maggot or Railroad Worm (Rhagoletis pomonella).

This maggot is a serious pest of apples in some districts. It is probably a native species, and occurs widely in both the United States and Canada.

Adult.—A small fly, a little smaller than the house-fly; blackish, with yellow head and legs; eyes green; 3—4 white bands (3 in male and 4 in female) across the abdomen; wings marked by four dark irregular bands. July and later, each female capable of laying 300—400 eggs; and uses sharp ovipositor to puncture the skin of the fruit.

Eggs.—Elliptical, yellowish pedicellate, 1-30 inch long; laid singly just under the skin of the apple; hatch in 4—5 days.

Larva.—A small, plump, white, legless maggot, ¼ inch long; mouth parts with a pair of small black rasping hooks; caudal end truncate; makes soft discolored trails in the pulp; full grown in 4—6 weeks, or when the infested fruit is ripe. Infested apple usually falls.

Pupa.—Puparium just beneath the surface of the ground in which the pupa rests all winter.

Life History.—Hibernates as pupa in the ground; adults begin to emerge in July, and appear irregularly later; maggots hatching from the eggs tunnel in the flesh of the fruit, sometimes close to the surface. They mature in 4—6 weeks, and make their way out of the apple to the ground. Infested fruit usually falls. There is but one generation each year.

(Consult Rep. Maine Ag. Exp. St., 1889; Cir. 101, Bureau of Ent., U. S. Dep. Agric.)

9. Muscidae.

House or Typhoid Fly (Musca domestica).

Adult.—A two-winged fly with four black lines on back of thorax; bristle of antennæ feathered; vein ending near tip of wing distinctly elbowed; no bristles on abdomen except at the tip. Mouth parts used for sucking not for piercing retractile; mouth-parts and feet specially adapted for carrying micro-organisms. Each foot with two claws and two sticky pads. Hibernates in sheltered situation. Egg-laying begins 10—14 days after adult emerges from puparium.

Eggs.—Minute, glistening white, long ovoid, $\frac{1}{20}$ inch long. Laid in irregular small clusters. Each female lays about 120 eggs at a time and may lay several times; hatch in about 8 hours in midsummer.

Larva.—At first glistening white; moults twice; duration about 5 days; when full grown yellowish; slender in front and truncate behind; a large hook above the mouth; active.

Pupa.—Puparium nearly cylindrical, a dark chestnut; duration 3—4 days. The House Fly will breed in almost any fermenting organic matter, but preferably horse manure. Duration of life-cycle 10—14 days. Probably about seven generations between April 15 and September 10.

(Consult Hewitt's "House Flies."

Stable Fly (Stomoxys calcitrans).

Adult.—Resembles House Fly, but has piercing mouth-parts; six black lines on thorax.

Eggs.—Laid in an irregular heap of about 100; hatch in 2—3 days; similar in form to those of House Fly.

Larva.—Similar to that of House Fly. Duration 10—20 days.

Pupa—Duration 6—20 days; puparium reddish brown, elongate oval, ¼ inch long. This fly occurs in the open, but often enters houses; breeds rapidly in straw refuse.

(Consult Farmers' Bulletin 540, U. S. Dep. Agric., 1913.)

Horn Fly (*Haematobia serrata*).

Adult.—Similar in shape and color to House Fly, but about half as large. June—September.

Eggs.—Laid singly in fresh cow manure in day time, irregular, oval, light reddish brown. Egg laying soon after adult emerges.

Larva.—White, ¼ inch long; full grown in 4—6 days.

Pupa.—Puparium dark brown, ellipsoidal, ¼ inch long; pupal stage lasts 5—10 days. Probably 6—8 generations in a season.

[redacted]

Blue-Bottle or Green-Bottle Flies.

There are two or three species of these flies, and they are also known as Blow Flies.

1. *Meat Fly or Blow-Fly* (Calliphora vomitoria)—A large blackish fly with bluish abdomen, black spines on the thorax. Its eggs are laid on meat and dead animals, and each female may lay 400—600 eggs, which hatch very soon after deposition. Duration of a generation 22—23 days.

2. *Blue-Bottle Fly* (Lucilia Caesar)—Similar in habits to Meat Fly. Hibernates as adult.

ii. Anthomyiidae.

Root Maggots (*Phorbia spp.*).

Two species of root maggots are commonly injurious to root crops:

(1) *Cabbage Maggot* (Phorbia brassicæ), which infests the roots of cabbage and radish; and

(2) *Onion Maggot* (Phorbia cepurum), which mines the roots and bulbs of onions.

The adults of these two species are 2-winged flies, smaller than the house fly.

(1) *Phorbia brassicae* (*Cabbage Root Maggot*).

Adult.—Smaller than house fly; 3-16 inch long; grayish, with a dark stripe along back of abdomen; a number of stiff hairs on body and legs. Hibernates as adult.

Eggs.—Elliptical, white, 1-25 inch long; deposited on the surface of ground or on stem of plant; stage lasts a week.

Larva.—A whitish cylindrical footless maggot, tapering towards the front, and abruptly terminated behind; ¼ inch long when full grown (3 to 4 weeks).

Pupa.—Puparium in earth, oval, chestnut-brown.

Life History.—Adults appear in May, when cabbages are being set out and eggs deposited. Maggots hatch in a week and feed on roots for three or four weeks when they change to pupæ within puparia in the soil. In 15 days or so the adults appear in late June to lay eggs for a second brood. The number of broods is uncertain, but the later broods do but little harm.

(2) *Phorbia ceparum* (*Onion Maggot*).

Adult.—Larger than P. brassicae but otherwise very similar to it in the various stages of development. Infests onions.

(3) *Pegomyia vicina* (*Beet Leaf Miner*).

Is sometimes destructive to beets in late fall. Whitish blotches are formed on the leaves. There are several generations each year, and the winter is passed in the pupal condition under fallen leaves.

(4) *Seed Corn Maggot* (*Phorbia fusciceps*).

Adult.—A two-winged fly, ¼ inch long, about the size of a small house fly. The male has a row of short rigid bristly hairs on the inner side of the posterior tibiæ.

Eggs.—White.

Larva.—A maggot about ¼ inch long, footless and cylindrical, narrower at anterior end, feeding on kernel in the ground.

Pupa.—Yellow, about ¼ inch long; in the ground.

Life History.—Not definitely known. Adults appear in June and deposit eggs. The young maggots feed upon germinating kernels.

(5) *Raspberry Cane Maggot* (*Phorbia rubivora*).

Adult.—A grayish-black fly, smaller than the house fly. April.

Eggs.—White, elongate, 1-15 inch long, laid in the axil of young leaf at the tip of shoot. Hatch in a few days.

Larva.—Maggot bores into the pith of the shoot, and tunnels downwards, making a tortuous path. About half way down it girdles the wood beneath the bark. It continues burrowing downward and becomes full grown in June.

Pupa.—Formed at lower end of burrow. June and July. Wilting occurs in May.

12. Tachinidae.

Tachina Flies.

These flies are useful in that the larvæ or maggots are parasitic within the bodies of injurious caterpillars. The female tachina fly lays her eggs upon the caterpillar, and the maggots on hatching bore their way through the walls and live within the body until full grown. Tachina flies resemble house flies but are usually more bristly and hairy. The bristles of the antennæ are entirely bare. They are frequently found about flowers and rank vegetation. Besides caterpillars, such as army-worms and cutworms, locusts, leaf-eating beetles and other injurious forms are kept under control by tachina-flies.

13. Pulicidae.

Fleas.

Two species of fleas are found infesting houses: The House Flea (Pulex irritans) and the Cat and Dog Flea (Pulex serraticeps), but probably the latter species is the more abundant.

(1) *House Flea* (Pulex irritans) secretes itself in bedding and clothing, and attacks its human victims at night.

Adult.—Body compressed; wingless; legs long and stout; tarsi 5-jointed, and mouth parts adapted for sucking; antennæ small, eyes simple.

Eggs.—Laid in dust or lint under carpets and other out-of-the-way places, whitish and ovoid; in summer hatching in 4—6 days. Each female lays 8—12 eggs.

Larvæ.—Live and feed in dust or litter; slender, worm-like, footless, sparsely haired; full grown in summer in about 11 days.

Pupæ.—Formed where larvæ live, often enclosed in small silk cocoon, covered with dust. Duration about 12 days.

(2) *Cat and Dog Flea* (Pulex serraticeps).

Adult.—Like that of House Flea but with a comb of spines on border of head and pronotum. Adheres quite closely to its host.

Eggs.—Laid loosely among the hairs of host; small white and oval; hatch in about 2 weeks. Collect on mats.

Larvæ.—At first white, footless, maggot-like; head pale yellow; feed on decaying particles of animal and vegetable matter; mature in summer in about 12 days.

Pupæ.—Duration 12—16 days in summer in a cocoon. This flea may be found in winter in any of the stages. Several broods each [illegible]tion.

14. Hippoboscidae.

Sheep Ticks.

These are wingless, brownish, flattened blood-sucking insects belonging to the "Flies." They are often very injurious to lambs in spring after shearing time.

Sheep should therefore be dipped after shearing in some good "dip," of which several kinds are on the market.

IX—HYMENOPTERA.

The Principal Families of Hymenoptera.

A. Trochanter simple; female with sting.

B. First segment of the hind leg more or less compressed, at least on inner side, and often thickly hirsute .....
Apina (Bees)

Larva: no legs.
except in sawfly group. = 8 pairs no legs
31 - Pima

BB. First segment of hind leg more or less cylindrical, neither markedly broadened nor hairy.

C. Anterior wings folded once lengthwise; antennæ usually clearly bent at an angle .....
Vespina (Wasps).

CC. Anterior wings not folded lengthwise.

D. Abdomen appended or pedunculate, oval or broadest anteriorly, gradually tapering posteriorly .....
Superfamily—*Sphecina* (Digger and Mud Wasps).

DD. Abdominal stalk formed of one or two knots or scale-like rings; antennæ flagellum-like .....*Formicidæ* (Ants).

AA. Trochanter of two segments; female with ovipositor.

B. Abdomen sessile or joined broadly to thorax.

C. Tibia of forelegs with two apical spurs; female with saw-like ovipositor.....
Tenthredinidæ (Saw-flies).

CC. Tibia of forelegs with one apical spur; female with ovipositors fitted for boring .....
Siricidæ (Horn-tails).

BB. Abdomen joined to thorax by slender petiole or stalk.

C. Fore-wings with few or no cross veins, hence with no closed cells.

D. Ovipositor issuing before the apex of the abdomen .....*Chalcididæ* (Chalcis-flies).

DD. Ovipositor issuing from the apex of the abdomen .....*Proctotrupidæ*.

CC. Fore-wings with one or more closed cells.

D. Fore-wings without a stigma .....
Cynipidæ (Gall-flies).

DD. Fore-wings with a stigma.

E. Fore-wing with vein between V_1 and 1st V_2 wanting .....
Braconidæ (Braconid-flies).

E. Fore-wing with vein between V_1 and 1st V_2 .....
Ichneumonidæ (Ichneumon-flies).

1. Tenthredinidae (Saw-Flies).

Currant Stem Girdler (Janus integer).

Adult.—A slender black saw fly with yellowish legs; male smaller than female, with abdomen brownish yellow. Abdomen in female is half reddish-orange and half black. May. Stem girdled by female.

Eggs.—Deposited in pith of cane; elongate oval, yellowish-white, 1-25 inch long. Laid in May and June; hatch in about 11 days.

Larva.—½ inch long, straw color; head darker yellow; thoracic segments broadest; tip of abdomen with a horny brown bifid spine. Winters in a silken cocoon.

Pupa.—Pupates in April; white. Wilting occurs in May.

Control.—Cut off and burn infected canes 8 or 10 inches below the girdled part, in June or fall.

Imported Currant Worm (Pteronus ribesii).

Adult.—Four-winged saw-flies, ½ inch long, light yellow, marked with black; male is smaller and darker; May, June, and July.

Eggs.—Laid in rows on leaves along the midribs; hatch in four to ten days.

Larva.—At first whitish caterpillar with white head and black spots on sides of body. Later color changes to green. When full grown, ¾ inch long, they descend to ground to pupate.

Pupa.—Formed in an oval brownish silken cocoon on the surface of the ground. That of second brood winters over.

Life History.—Two broods a year; adults emerge in spring and again in July. Broods overlap.

Control.—Dust or spray with hellebore or with an arsenical poison.

2. Ichneumonidae (Ichneumon-Flies).

These insects form an important group of parasites upon injurious forms. The females lay their eggs either within or upon the host larva, and the maggots feed within the host until maturity. Cocoons are often spun on the back of the host, from which emerge the adults. Some common genera are Ophion (light brown with compressed abdomen), Thalessa (with a long flexible ovipositor) parasitic on Pigeon Tremex, Pelecinus, Pimpla parasitic on Tent-caterpillars and Tussock Moths, and Trogus parasitic on Chrysalids of Papilio.

3. Braconidae (Braconid-Flies).

Braconids are as a rule smaller than the Ichneumons, but like the latter are valuable parasites. Some forms like Aphidius parasitize plant-lice, others like Apanteles live on tomato, cabbage and other worms; others like Microgaster upon Grape Sphinx Caterpillars, and Meteorus.

Braconid-flies are wasp-like, brownish or yellowish-black, and about ¼ inch long.

4. Chalcididae (Chalcis-Flies).

The great majority of Chalcis-flies are beneficial as parasites on injurious insects. They are minute metallic insects with stout heads and bodies. They are recognized by the branched single vein of the fore-wings. Their larvæ attack many species of caterpillars. Among the most common forms are Pteromalus on the pupæ of the Green Cabbage Butterfly, Aphelinus on scale insects, Monodontomerus æreus on the Brown-tail and Gipsy Moths, and Trichogramma on many caterpillers.

Joint Worm (Isosoma tritici).

Adult.—A minute black 4-winged gnat; ⅛ inch long.

Larva.—A yellowish-white maggot ¼ inch long, tips of jaws brown.

Pupa.—In swellings or galls at the joints.

Control.—Rotation of crops; burning and plowing under of stubble when practicable, or harvesting stubble in spring, collecting with horse-rake and burning; preparation of good seed bed.

Clover Seed Chalcid (Bruchophagus funebris).

Adult.—A minute black four-winged fly, 1-12 inch long.

Egg.—Elliptical with a slender tube, whitish and smooth.

Larva.—A white stout footless maggot, 1-15—1-12 inch long.

Pupa.—Dark and less than 1-12 inch long.

Life History.—This insect usually winters over in the seed as a well-developed larva; the pupal stage is rather short and the adult lays her eggs in May and June. First of the adults of this brood appear in July and August, but some do not come out till the following spring. There is much overlapping of stages and the number of broods is difficult to determine. Folsom traced as many as three generations per year, with a possibility of four.

As yet this Chalcid has not been reported injurious in clover fields in Canada.

5. Proctotrupidae.

These constitute the smallest of insect parasites, infesting mainly the eggs of insects. They are very minute, black and without metallic lustre. Sometimes they occur as secondary parasites on other parasites.

6. Formicidae.

House Ants (Monomorium pharaonis).

These are the little red ants that have their nests in the wall, or beneath the flooring, and are nuisances about houses. The black ant (M. minutum) and the pavement ant (Tetramorium caespitum) are also occasionally found in houses.

Adults.—Worker neuters, winged males and females, and wingless females constitute an ant colony.

Eggs.—Laid in immense numbers by the solitary queen mother; minute, oval, whitish; cared for by the workers.

Larvæ.—Fed by workers.

Pupæ.—White, cared for by workers; egg-like but much larger than the true eggs.

(Consult Cir. 34, Div. Ent. U. S. Dep. Agric.)

Control.—Destroy nests with hot water or carbon bisulphide; trap ants in sponges soaked in sweetened water.

Apina (Bees).

The bees are grouped into two families, the *Andrenidæ* (Short-tongued bees) and the *Apidæ* (Long-tongued bees). In provisioning their nests with honey or pollen, or both, which they collect from

flowers, bees are of great economic importance in the cross-fertilization of many flowers. (See Part I, F.)

Most of the Andrenidæ are miners and make their nests in the ground. They are solitary, each female making her own nest, but frequently the nests are close together. Some of the more common genera are Andrena, Halictus and Prosopis.

To the Apidæ belong the Leaf-cutter bees (Megachile), Carpenter-bees (Ceratina and Xylocopa), Guest-bees (Psithyrus), Bumble-bees (Bombus) and Honey-bees (Apis). (See manuals of Comstock and Kellogg, and Sladen's "Humble-Bee" for details regarding the habits of bees.)

Vespina (*Wasps*).

The true wasps are divided into the *Solitary Wasps* (Eumenidæ) and the Social Wasps (Vespidæ). Of the latter two genera are common, viz.: *Polistes* with a slender reddish abdomen, and black ringed with yellow, and *Vespa*, the common hornet or yellow-jacket. The paper nests are provisioned with spiders or insects.

Sphecina (*Digger-Wasps*).

The Digger-wasps contain a large number of families. (See Comstock's Manual, pp. 646—7).

They are solitary and store their nests with insects or spiders. The nests vary in structure; some are made of mud attached to ceilings of buildings; some made in the pith of elder, sumach, etc.; and others in sandy banks. The more common genera are Tiphia, Pelopoeus, Sphecius, Stigmus and Trypoxylon.

X.—MALLOPHAGA.

Biting Lice.

Although most commonly found on poultry Biting Lice sometimes infest the larger domestic animals. They do not suck blood but feed on the rough parts of the skin and base of hairs and feathers, causing considerable irritation. Young chicks frequently suffer severely from their attacks.

The most common species found on fowls is the common hen louse (Menopon pallidum), a pale yellow active insect, 1-25 inch long, with six legs.

The eggs or "nits" are oval objects attached to the vanes and barbs of the feathers, usually on the down feathers. They hatch in 8 to 10 days and become full grown in 2 to 3 weeks.

Dampness, filth and warm weather favour their increase.

Control.—(*a*) Sanitary surroundings with access to a dust bath; (*b*) Dusting with lice powder, such as insect powder, or one prepared as follows, 3 parts gasoline, 1 part crude carbolic acid (90—95%), or 1 part cresol. Mix together and add, with stirring, plaster of Paris to take up all the moisture (about 4 qts. to 1 qt. of liquid). All remedies should be applied more than once.

XI.—MITES.

Poultry Mites.

The most common form is the Chicken-Mite (Dermanyssus gallinæ), a flattened, elliptical mite, with 8 legs, 1-40 inch long, distinctly reddish after feeding.

The eggs are laid in cracks and crevices of the wood or straw of the nests and roosts. They become mature in about ten days. They are most active at night.

Control.—(*a*) Cleanliness and sunlight, as mites thrive best in damp, dirty houses; (*b*) remove droppings and all old nesting material; (*c*) clean and scrub or wash with water all the perches, roosts, nests, floor and walls; (*d*) spray or paint these with a 5% cresol, or with 3 parts kerosene and 1 part crude carbolic acid, or with kerosene emulsion. Two or three applications are necessary at intervals of a few days.

When houses are whitewashed, 4 oz. crude carbolic acid should be added to each gallon of whitewash. It is often advantageous to scatter a mixture of three parts of dry slacked lime and one part sulphur with the doors and windows closed.

Other Mites.

1. *The Itch Mite* (Sarcoptes mutans) produces "scaly-leg" of fowls, turkeys, etc. It may also attack the comb and beak. The disease is contagious. The mites bore under the scales of the foot and leg and burrow deeper and deeper into the tissue, setting up an irritation, frequently a lameness, and sometimes the loss of some of the toes.

Control.—(1) Oil of caraway (1 part to 5 parts white vaseline) rubbed into leg and foot every few days; (2) bathing in warm soapy water and applying sulphur ointment or naphthaline mixed with 9 parts lard, or 5% creolin or zenoleum, or vaseline and zinc ointment.

2. *The Depluming Mite* (Sarcoptes gallinæ) causes the feathers to break off at the surface of the skin. This depluming occurs on different parts of the body. The exposed skin is normal.

Control.—As for the Itch Mite.

Sheep Scab Mites.

These mites are more closely related to spiders than to insects. They breed in large numbers under crust-like scales on the skin of sheep. The neck, back and rump are the parts usually affected, and the wool becomes ragged, sometimes falling off.

Sheep should be dipped with one of the many scab and tick "dips" on the market.

Part IV.

THE CONTROL OF INJURIOUS INSECTS.

The effective control of injurious insects demands a knowledge of the habits of the insects themselves so that they may be attacked at the most vulnerable point. As insects differ greatly in their habits and life history, methods of control must also differ greatly, not only with regard to individual insects, but also with regard to the crops that are attacked. For example, it is obvious that insects that live mostly in the ground and injure roots must be controlled in a different way from insects that feed on foliage. Moreover, insects that attack the cereal crops of the farm cannot profitably be treated in the same way as insects that attack the fruit and leaves of garden or orchard crops.

The various methods of control of injurious insects may, therefore, be grouped into two general classes: a. *Cultural* or *Preventive Methods*—those practices of culture or of handling the crop that prevent, or interfere with, the development of injurious insects; and b. *Artificial* or *Remedial Methods*—those which deal with injurious insects when they appear by the use of poisonous or contact substances, or other artificial means.

a. Cultural or Preventive Methods.

For most farm crops Cultural Methods are the only practicable methods. They are essentially Preventives. The most important cultural methods are the following:

1. *Rotation of Crops.*—The growing of crops year after year on the same land permits many insects which feed on the roots to develop and multiply. On the other hand, a good crop rotation makes it impossible, or very difficult, for an insect to pass through its life stages without being seriously disturbed and its food supply destroyed.

(*a*) Some rotations are preferable to others when wireworms and white grubs are abundant. For example, where corn is the chief crop a rotation of clover, corn, oats is better than forage grasses, corn, oats. Professor Forbes, of Illinois, advises plowing the grass in early fall, and sowing clover either with barley, wheat, or rye.

The clover is allowed to stand two years and is followed by corn or roots. Certain crops such as clover, barley, wheat and rye, are not so liable to attack as are corn, potatoes, mangels, oats; hence, they are better adapted to follow sod.

(*b*) Moreover, if sod infested with white grubs is broken up early, sown to turnips or rape, and pastured with hogs in late summer and autumn most of the white grubs will be destroyed by the hogs. As the grubs burrow deeply at the approach of cold weather it is not advisable to pasture hogs late in the season. Clover is seldom attacked by white grubs, and hence, is useful as a "starvation" crop before planting to corn, potatoes or mangels.

(*c*) Where the Clover-Root Borer is injurious in second year clover fields, plow up the sod after the first season.

2. *Good Cultivation.*—This involves careful treatment of the soil, the crop, and its products. (*a.*) It means careful attention to the waste products and the waste places which are breeding places for many injurious insects. (*b.*) It means the adoption of deep, late fall plowing under certain conditions, which practice is one of the best methods of dealing with wireworms, white grubs, cutworms and grasshoppers. (*c.*) It means high fertility of soil, and good drainage of the land so that vigorous healthy plants, capable of resisting the drains of insect attacks, are grown instead of poorly nourished plants which are more likely to succumb.

Timely plowing, planting, and harvesting are often effective against some of the worst insects of the farm. For example, two or three fall plowings destroy large numbers of maturing wireworms and white grubs; early plowing of grass in August destroys the eggs and larvae of cutworms and grasshoppers. Late sowing of fall wheat prevents Hessian Fly injury; and early cutting of the first crop of clover destroys the first brood of the Clover Seed Midge, and thus saves the clover seed of the later crop.

The destruction of rubbish, screenings, stubble, dead stalks and weeds deprives many hibernating insects of resting or breeding places. Such insects are, Hessian Fly "flax seed." Chinch Bug, Clover Hay Worm, Tarnished Plant Bug, Squash Bug, Stalk Borers, etc.

Cutworms endeavor to lay their eggs in September on weeds and grasses. If the land is kept free from weeds and the grass is fed or mown few cutworms will appear the following spring.

The application of fertilizers is often advantageous in forcing the growth of plants that are attacked, and in repelling insects. Kainit, nitrate of potash, barnyard manure, wood-ashes, and tobacco dust are said to be effective.

3. *Co-operative Measures.*—Co-operation among the farmers of a district is required for the successful control of certain insects such as the Hessian Fly, the Pee weevil, the Codling Moth, the San Jose Scale, the Plum Curculio, the Apple Maggot, Grasshoppers and many others.

4. *Natural Enemies of Insects.*—(*a.*) Farmers and fruit-growers can do much to encourage the presence of insectivorous birds among the crops. These birds are most important in keeping injurious insects under control.

(*b.*) Frequently, too, hogs and poultry can be utilized to advantage in destroying white grubs, cutworms, grasshoppers, asparagus beetles, etc., in infested fields.

(*c.*) Lady-bird beetles, ground beetles, and other predaceous insects should be protected as far as possible.

b. Artificial or Remedial Methods.

Artificial methods may be conveniently classified as follows:—

1. The application of poisons against biting insects.
2. The application of contact substances against sucking insects
3. The use of poisonous gases.
4. The application of repellent substances.
5. The use of protectors.
6. The use of traps and trap crops.
7. The use of ditches.
8. The use of hopperdozers, etc.
9. Collecting, digging out, jarring, etc.

1. The Application of Poisons for Biting Insects.

The essentials of a good insecticide are:—(1) It must be effective against insects and at the same time harmless to plants; (2) it should be cheap; and (3) it should be easy of application.

The most important poisons used for the destruction of biting insects are (*a.*) Paris Green; (*b.*) Arsenate of Lead; and (*c.*) Hellebore. When leaves or other portions of plants, dusted or sprayed with suitable quantities of these substances, are eaten by insects the latter are poisoned. As a rule, better results are secured by spraying the plants than by dusting them; sometimes, however, it is impracticable to spray and resort must be had to dusting.

White arsenic is insoluble and thus must be dissolved so we must. Stock solution

1 lb As_2O_3
1 " Sal Soda. Na_2CO_3
1 gal H_2O
2 lbs quicklime

Boil first two together for 2 hours add the lime. Make up to 2 gals. = Stock Solution
2 qts to 40 gallons water.

(*a.*) *Paris Green.*—Pure Paris Green is soluble in ammonia but only slightly soluble in water. In commercial forms there is usually a small amount of free arsenious acid, so that it is necessary to add lime to prevent injury from the burning of the foliage. The amount of lime used should be at least equal to that of the Paris Green. When Paris Green is added to Bordeaux Mixture the excess of lime renders the addition of extra lime unnecessary.

Paris Green particles are heavy and sink readily in water. However, the finer the particles are the longer they remain in suspension, consequently the Paris Green should first of all be made into a thin paste in a small amount of water, and after it is in the barrel it should be kept in suspension in a mixer.

The regular formula is:—

Paris Green, 1 lb.; Best Stone lime, 1 to 4 lbs.; Water, 160 gallons.

The Paris Green is made into a paste with water and stirred into the lime-and-water mixture.

When used as a dry application for the potato beetle, one lb. of Paris Green is thoroughly mixed with 50 lbs. cheap flour, or air slaked lime or fine sifted land plaster.

(*b.*) *Arsenate of Lead.*—This insecticide is preferred by many fruit growers to Paris Green since it adheres better to foliage, is less likely to do injury, and no lime is required in standard preparations. A good brand should contain 20 per cent. arsenic trioxide. It may be prepared at home by dissolving acetate of lead, 11 oz., and arsenate of soda, 4 oz., in 120 gallons of water.

For fruit trees two pounds or arsenate of lead to the barrel of water is the usual strength. For the Potato Beetle three pounds to the barrel should be used.

(*c.*) *Hellebore.*—Sometimes used as a substitute for arsenicals, especially against root-maggots, on fruit which is nearly ripe. It may be applied dry or liquid: Dry with five parts of flour or air-slacked lime; liquid at the rate of one ounce of Hellebore to two gallons of water.

Although an internal poison to insects it is harmless to man in the quantities named. It is too expensive for use on large areas.

2. The Application of Contact Substances Against Sucking Insects.

The main substances used as Contact Insecticides against sucking insects are:—(*a.*) Lime-sulphur Wash; (*b.*) Whale-oil Soap; (*c.*) Kerosene Emulsion; (*d.*) Pyrethrum; (*e.*) Tobacco Decoction: (*f.*) Lime Dust; (*g.*) Carbolic Acid Emulsion.

These substances act by corroding the body or by stopping the breathing pores.

(a.) *Lime-sulphur Wash.*—This wash came into use in the control of the San Jose Scale on dormant wood. Its beneficial effects were evident also against other insects and against certain fungous diseases.

It is prepared in two forms: Home-made Lime-sulphur Wash and Commercial Lime-sulphur Wash, diluted to use on dormant wood and on summer foliage.

I Home-made Preparation, Boiled:—Lime (best), 20 lbs; Sulphur (flowers), 15 lbs.; Water, 40 gallons.

II. Concentrated Formula, Stock Wash:—Lime, 50 lbs.; Sulphur, 100 lbs.; Water, 40 gallons.

(Directions for preparing these washes are given in special bulletins.)

A Hydrometer is used to ascertain the proper dilution. "For use before buds burst" dilute to sp.gr. 1.03; "before blossom burst." 1.009; and "just after blossoms fall," 1.008. To get the amount of dilution divide the reading after the decimal point of the stock solution by the reading after the decimal point of the solution desired. For example, if the hydrometer reading of the stock solution is 1.3 and that of solution to use "before buds burst" is 1.03, the amount of dilution is 30-3=10. That is 1 gallon of stock solution makes 10 gallons of spray.

Commercial Wash.—Commercial Washes are now sold which are quite reliable. Directions are given as to dilution.

It is to be noted that Lead Arsenate, not Paris Green, is to be used with the Lime-sulphur Wash.

(b.) *Whale-oil Soap.*—Potash whale-oil soap of a good grade, when dissolved in warm water at the rate of two pounds to a gallon of water, makes an excellent spray for early spring treatment of orchards—just before the buds swell. It is also valuable as a summer treatment against aphids as pear psylla, but it should be diluted as follows: 1 lb. of soap dissolved in 3 to 4 gallons of warm water. The soap has an invigorating effect on the tree, but its cost prohibits its use in orchards on a large scale.

(c.) *Kerosene Emulsion.*—A soap emulsion of kerosene has for many years been used against aphids and other sucking insects. It is prepared by dissolving ½ lb. soap in one gallon of warm water. and adding two gallons of kerosene to the hot soap solution. The whole is then agitated until a creamy emulsion is formed. This stock

Can be used in stables.

solution when properly made keeps indefinitely. When required for use the stock solution is diluted with 10 times its volume of water.

(*d.*) *Tobacco Decoction.*—A strong decoction of tobacco stems or leaves is an excellent remedy against aphids, either in the field or in the greenhouse. The decoction is an extract and is made by steeping refuse tobacco in water for several hours until a deep brown liquid is obtained, or by boiling the tobacco in water for half an hour. Two lbs. of tobacco are treated in two gallons of water and afterwards made up to five gallons. It is a safe remedy.

(*e.*) *Pyrethrum.*—Pyrethrum, known also as Buhach, Persian and Dalmatian insect powders, and by other trade names, is used frequently on aphids, slugs, and some household pests, where operations are confined to a small area.

It may be used either as a spray or in the dry form. As a spray it should first of all be made into a paste in small quantity of water and afterwards diluted to the proper strength, viz.: one ounce to 3 gallons of water. When used dry, one part of powder is thoroughly mixed with four parts of flour, and kept in a tight can for a day. The mixture is dusted on either by a bellows or through a coarse bag.

Pyrethrum loses its strength on exposure to the air; therefore, the can must be kept tightly closed.

(*f.*) *Lime.*—Air-slacked lime is effective against slugs and other soft bodied larvae. It should be applied as a very fine dust.

Some investigators report beneficial effects from the application of thick lime-wash about onion plants as soon as they are up as a protection against the onion maggot.

(*g.*) *Carbolic Acid Emulsion.*—For the control of root feeding larvae such as the onion maggot and radish maggot, an emulsion of carbolic acid has given good results. It is prepared by dissolving one pound of hard soap in one gallon of hot water and adding one pint of crude carbolic acid. The mixture is agitated until a thick, emulsion is produced. This is the stock solution, and is diluted with 20-30 parts of water for use. A tablespoonful is poured about the base of the plant to prevent egg-laying, and at the same time to kill the newly hatched larvae.

3. The Use of Poisonous Gases.

The more important poisonous gases used to control insects are:—(*a.*) Carbon bisulphide; (*b.*) Hydrocyanic acid gas; (*c.*) Sulphur dioxide; and (*d.*) Tobacco.

(*a.*) *Carbon bisulphide.*—This is an ill-smelling liquid which is readily volatile. The gas is much heavier than air, and if placed in

shallow pans above or on top of grain or other vegetable foods the fumes sink, and being poisonous will kill the insects. It is specially valuable for the fumigation of peas infested with weevils, or grain infested with weevils and other insects. It is also used for the destruction of house-hold pests such as clothes' moth, etc.

One pint of the liquid is sufficient for 100 bushels of peas or grain, or 1,000 cubic feet of space. It is inflammable.

(*b.*) *Hydrocyanic Acid Gas.*—This gas is liberated when diluted sulphuric acid is added to potassium cyanide. It is a deadly poisonous gas, and great care should be taken in its use as an insecticide.

It came into use in California for the fumigation of citrus and olive trees. Later it was introduced into eastern nurseries for the treatment of San Jose Scale on dormant nursery stock, and for the control of flour mill pests, and in some cases, greenhouse and household pests.

The simplest formula is:—

Cyanide of potash (90 per cent. pure) 1 ounce; Sulphuric acid (sp.gr. 1.53) 1 fl. ounce; Water, 4 fl. ounces.

This gas is lighter than air and diffuses very rapidly.

(*c.*) *Sulphur Fumes.*—The destructive action of sulphur is largely due to the readiness with which it oxidizes to sulphur dioxide, a gas fatal to many forms of insect life. Mites are controlled in greenhouses by the dusting of fine sulphur on the surfaces of the leaves.

When sulphur is burned on a hot plate over a low flame sulphur dioxide is rapidly formed, recognized by its suffocating odor. This is, perhaps, the simplest method of dealing with ordinary household pests such as bed-bugs, fleas, and other forms.

Combined with a soap, sulphur is used as a wash for mange which is caused by a mite.

(*d.*) *Tobacco.*—Tobacco fumes are destructive to aphids on greenhouse and household plants. They are liberated by the application of heat to certain Nicotine Extracts, Nicotine Paper, or finely divided tobacco powders. These "fumigating" powders and extracts may now be had in the market and are convenient methods of dealing with house plants.

4. The Application of Repellant Substances.

Several substances are known to act as "repellents" to insects, and may sometimes be used to advantage in preventing insect attack. Among such substances are:—(*a.*) Bordeaux mixture; (*b.*) Tobacco

dust; (*c.*) Carbolic acid emulsion; (*d.*) Kerosene; (*e.*) Turpentine; (*f.*) Coal tar; (*g.*) Naphthaline; (*h.*) Zenoleum and Creolin compounds; (*i.*) Tanglefoot, etc.

(*a.*) *Bordeaux Mixture.*—This mixture keeps away flea-beetles from potato leaves when applied as a fine spray.

(*b.*) *Tobacco dust.*—In the case of certain garden crops fine sprinkling of the ground when it is moist with refuse tobacco dust not only fertilizes the soil but also repels the striped cucumber beetle and the melon aphis.

(*c.*) *Carbolic acid emulsion.*—Carbolic acid is a repellent, as well as an irritant and stomach poison, and in various forms is used for the control of insects. Reference has already been made to its use as a contact insecticide. As a repellent it is added to a solution of washing soda or lye as a protective wash against borers in orchards and shade trees; as an emulsion with soap against root-maggots of cabbage and onion; and often also used in poultry house against biting lice and mites.

(*d.*) *Kerosene.*— (*e.*) *Turpentine.*—And (*f.*) *Coal tar* are sometimes mixed with saw-dust, sand, or other material; when placed around plants or seeds they are said to have a repellent action towards insects.

(*g.*) *Naphthaline.*—This substance is the basis of camphor balls, and is commonly used as a preservative of household good sand wearing apparel against the attacks of clothes' moths and other insects.

(*h.*) *Zenoleum and Creolin compounds.*—Some excellent compounds of creolin and related substances are prepared as repellents against flies that bother cattle, and against biting lice and mites of poultry. The cow horn-fly may be controlled by the use of such substances.

(*i.*) *Tanglefoot.*—A sticky substance, is used as fly-paper and as sticky bands for trees to prevent caterpillars such as those of Gypsy moth and Tussock moth from ascending.

5. The Use of Protectors.

Various forms of protectors are used to ward off insect attacks. The application is confined mainly to the orchard and garden. The following methods are those most commonly in use:—(*a.*) Metal or sticky bands; (*b.*) Cheese-cloth or muslin screens; (*c.*) Wire-netting.

(*a.*) *Metal or sticky bands.*—To protect trees from the attacks of climbing caterpillars such as the Tussock and the Canker worms,

special bands are placed about the trunk a few feet above the ground. The caterpillars are prevented from passing up, and they often collect in large numbers under the flaps or rim of the band where they are readily destroyed. The Gypsy, the Orchard Tent-caterpillars, climbing cutworms and Walnut caterpillars are also kept in check.

(*b.*) *Cheese-cloth or muslin screens.*—Such devices are often effective against cucumber beetles, flea-beetles and the radish root-maggot. As these insects are most injurious while the plants are just coming above the ground, the frames holding the screens should be placed in position soon after the plants are set out or the seeds planted. They can be readily removed for a short time whenever weeding or cultivation or watering is necessary.

(*c.*) *Wire-netting.*—Wire-netting is often placed about peach trees to protect them from the Peach-borer.

6. The Use of Traps and Trap Crops.

The following forms of traps are sometimes used to advantage.—(*a.*) Boards or chips; (*b.*) Special crops; (*c.*) Poison baits.

(*a.*) *Boards or chips.*—Squash bugs, cut-worms and other insects may be readily trapped in large numbers by placing small bits of board or chips or bunches of grass among the rows of plants where these insects hide.

(*b.*) *Special crops.*—Such crops have been found advantageous in the case of Hessian Fly, army worms, squash bugs, cucumber beetles, and asparagus beetles. In the case of the Hessian fly narrow strips are planted early so that the flies may deposit their eggs on the wheat before the regular planting of the field. These trap strips are then destroyed. With the army worm, a similar narrow strip on the border of the field may be poisoned with an arsenical spray. With cucumber beetles and asparagus beetles, a few plants may be set apart to trap the early beetles and then destroyed.

(*c.*) *Poison baits.*—Such are very effective against grasshoppers, cutworms and other insects. The Criddle Mixture, made by mixing thoroughly one part of Paris Green, two parts salt (dissolved in water), and one hundred parts of fresh horse droppings, with sufficient water to make the whole mass moist but not soggy, is used in the West against grasshoppers. When the mixture is scattered about grass lands and the edges of grain fields in hot, sunny weather the grasshoppers are readily poisoned.

The bait for cutworms in vegetable gardens and root fields is made by mixing thoroughly one pound of Paris Green in 25-50 lbs. of bran moistened with sweetened water.

For cockroaches in kitchens and pantries powdered borax mixed with sweetened chocolate is effective when the bait is scattered in the evening about the haunts of the insects.

Sponges filled with sugared water will attract ants that infest houses.

7. The Use of Ditches.

When fields are threatened with the army worm or grasshoppers, a ditch or deep furrow is made to good advantage. The insects falling into the ditch may be destroyed in large numbers.

8. The Use of Hopperdozers, etc.

In the grasshopper-infested regions of the West hopperdozers or hopper-catchers are used to great advantage. Various devices are in use, but they all agree in principle. They are essentially machines for gathering up the grasshoppers as they are drawn across an infested field. Attached to each machine is a device for destroying the insects when collected by means of coal-oil, or tanglefoot, or pitch tar.

Best results are secured by using the dozers when the hoppers are small. If infested fields are gone over frequently the damage will be reduced to a minimum.

9. Collecting, Digging-out, Jarring, etc.

Under this head are collected a number of mechanical methods which the careful farmer and fruit-grower employs to good advantage. Sometimes much damage can be averted by the timely picking of the eggs, larvae, or adults of insects such as the tobacco and tomato worms (Sphingidae), corn ear worm, potato beetle, celery caterpillar, white grubs, cabbage butterflies, early asparagus beetles, etc.

Again, it is often wise to cut out or burn certain insects whenever they appear. For example, web-worms, tent-caterpillars, stalk-borers, etc., may be effectively dealt with at certain stages in this way.

Sometimes, too, under certain conditions, insects can be controlled by jarring and beating the infested plants. When poisons are objectionable, this method of dealing with potato beetles, currant worms, etc., is recommended.